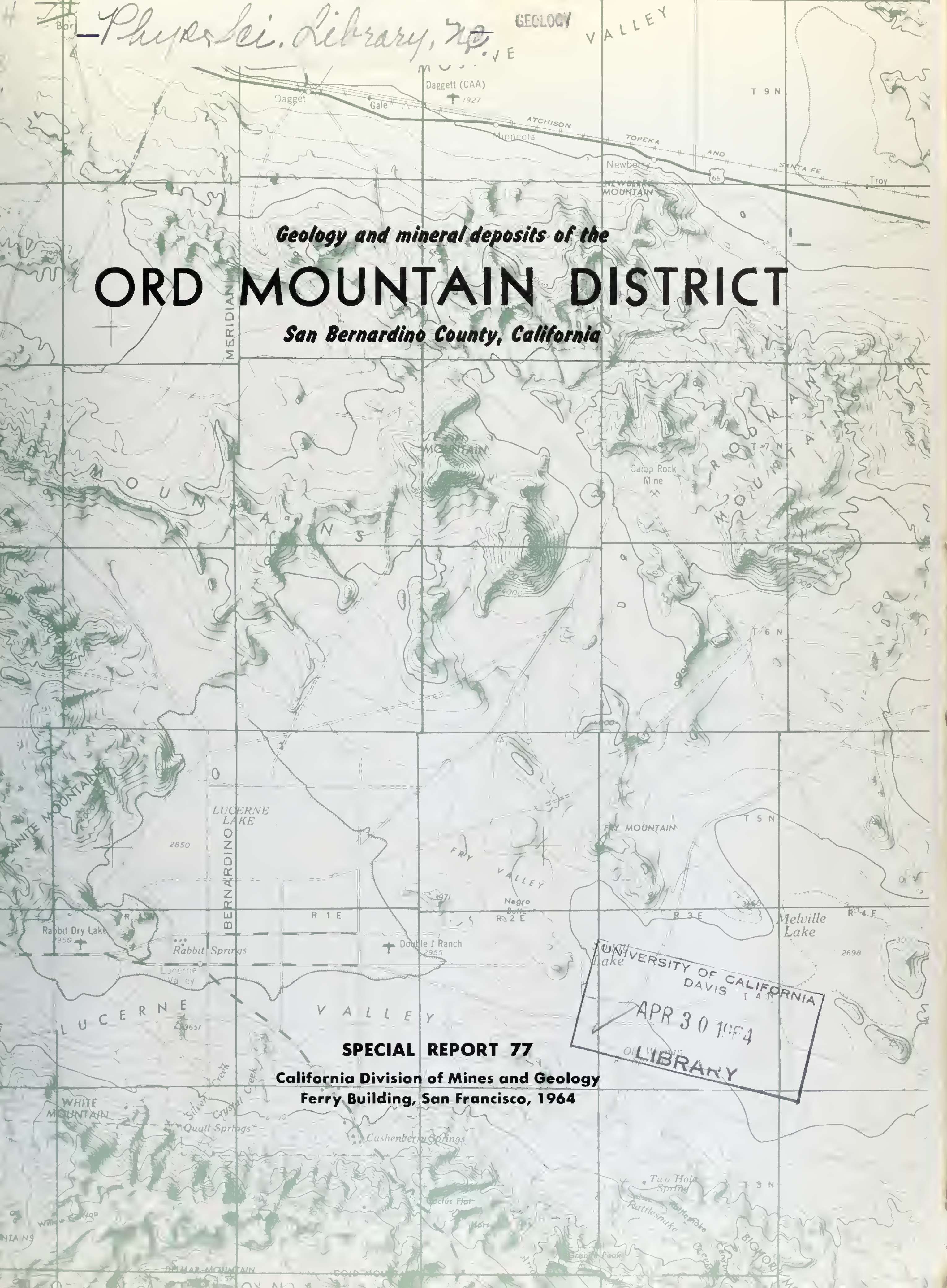

Geology and mineral deposits of the

ORD MOUNTAIN DISTRICT

San Bernardino County, California

SPECIAL REPORT 77

California Division of Mines and Geology
Ferry Building, San Francisco, 1964

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GEOLOGY AND MINERAL DEPOSITS OF THE ORD MOUNTAIN DISTRICT, SAN BERNARDINO COUNTY, CALIFORNIA

By F. HAROLD WEBER, JR., Geologist
California Division of Mines and Geology

SPECIAL REPORT 77
CALIFORNIA DIVISION OF MINES AND GEOLOGY
FERRY BUILDING, SAN FRANCISCO, 1963

CONTENTS

ILLUSTRATIONS

ABSTRACT

Ord Mountain is the central hump of the dark and rugged Ord Mountains, the highest range of the south-central part of the Mojave Desert of southern California. The oldest rocks in the district consist of a small patch of feldspathic quartzite and a very small body of crystalline limestone, which are of undetermined age, but probably no younger than Triassic. The next youngest unit, and most widespread in the district, is the Ord Mountain Group of metavolcanic rocks, which is dated questionably as Triassic. This Group can be divided into two major sub-units: the older sub-unit—extrusive andesite and interlayered tuff, rhyolite, and vesicular andesite, has been intruded by the younger sub-unit—keratophyre. The extrusive rocks have an estimated minimum thickness of about 16,500 feet.

The older rocks have been intruded by biotite quartz monzonite, and subordinate fine-grained granite and biotite granite, all of Jura-Cretaceous (?) age, which are exposed around the base of Ord Mountain. Also of Jura-Cretaceous (?) age are bodies of a hybrid rock (chiefly quartz monzonite to granodiorite), which may be igneous or metasomatic in origin. The youngest intrusive rocks are many basalt and rhyolite dikes, one diabase dike, two spherulitic rhyolite dikes, minor intrusive bodies of porphyritic biotite dacite, and hydrothermal fissure veins, which contain the principal mineral deposits of the district. These rocks may range in age from Cretaceous to late Tertiary. The youngest igneous rock is a small, cap-like remnant of rhyolite-dacite flow breccia, which probably is late Tertiary in age. Older, uplifted alluvium occurs in two areas in the north part of the area mapped, and younger alluvium has been deposited around the base of Ord Mountain.

The predominant structural trend of the district is northwesterly, as shown by the attitude of the layered rocks, dikes, and faults. The principal faults strike north to northwest and can be grouped as pre- and post-hydrothermal mineralization. The Ord Mountain fault zone has pre-mineral movement and contains the most important mineral deposits of the district. The most prominent post-mineral fault is the Tyler Valley fault, which strikes north-northwestward through the middle of the district, and separates Ord Mountain from the lower area to the west. Faults of both groups dip steeply and apparent horizontal separation along the post-mineral faults generally is right lateral.

Copper, with subordinate gold and silver, has been sought from the Ord Mountain district since about 1876, although total output is estimated to be less than 10,000 tons of ore. These metals occur in fissure veins which fit Lindgren's classification as mesothermal. The principal fissure veins were emplaced in faults of the Ord Mountain fault zone, which extends northward along the west side of Ord Mountain for perhaps 4 miles. The fissure veins of this zone dip steeply and range in thickness from about 5 to 25 feet; the most extensive is perhaps 9,000 feet long. The fissure veins consist of (1) individual ore mineral-bearing quartz veins and closely spaced veinlets, which are separated by sheared wall rock, and (2) nearly solid bodies of ore as much as 20 to 25 feet thick (but of relatively short length). The most productive property has been the Ord Mountain mine, which comprises a series of adits, shafts, and pits along the northern one-half of the Ord Mountain fissure vein system. The principal ore bodies found in the district have been mined in the Rio Vista workings of that mine. In addition to the Ord Mountain system of fissure veins, four subordinate systems also were recognized during the study, but prospecting in the veins of these systems has uncovered little ore.

Chalcopyrite is the most common hypogene ore mineral throughout the district, but bornite, molybdenite, and galena each are relatively common at one locality or more. Scheelite that occurs in at least one vein deposit is believed to be hydrothermal in origin. Pyrite is uncommon. The principal primary gangue minerals, in addition to quartz, are epidote, barite, and fluorite. Abundant secondary copper minerals are chalcocite and chrysocolla, which is very abundant. The common hydrothermal wall rock alteration minerals are quartz, chlorite, albite, sericite, and epidote. Very intense wall rock alteration may be indicative of additional ore bodies nearby.

The principal rocks in the district considered worthy of further exploration for copper and gold are (1) the part of the Ord Mountain system of fissure veins that lies vertically between the Rio Vista workings and the Central Tunnel of the Ord Mountain mine; and (2) possible large, very low grade copper deposits at the south end of the Ord Mountain system of veins, in the south part of the district.

Two deposits in the district are of contact metasomatic origin: (1) several very small bodies of magnetite which have been formed along the contact between an inclusion of crystalline limestone and hybrid rock; and (2) a scheelite-bearing metasomatized fault zone in metavolcanic rocks (White Dollar mine).

GEOLOGY AND MINERAL DEPOSITS OF THE ORD MOUNTAIN DISTRICT, SAN BERNARDINO COUNTY, CALIFORNIA *

By F. Harold Weber, Jr.

INTRODUCTION

Location, Accessibility, and Culture

The Ord Mountain district is in the west-central part of San Bernardino County, about 100 miles northeast of Los Angeles, California (figs. 1a, 1b). It embraces part of the Ord Mountains, a sprawling and arcuate range, which is the highest in the south-central Mojave Desert. Ord Mountain is the central hump of the range, and is separated by narrow valleys from East Ord Mountain, which lies to the southeast, and West Ord Mountain, which lies to the southwest (figs. 2 and 10). The Ord Mountains are bounded on the north by the Newberry Mountains and on the south by the Upper Lucerne Valley region. The area considered as the "Ord Mountain district" for this report includes all of Ord Mountain and part of the low hills and valleys which lie to the northwest of Ord Mountain. The area mapped comprises about 26 square miles (pl. 1).

The district can be reached from several small, nearby communities, party via paved roads and partly by improved and unimproved dirt roads (fig. 1b). It is about 10 miles via a graded county road from Daggett, which lies to the northwest, adjacent to U. S. Highway 66 and the Atchison, Topeka and Santa Fe Railroad. The district also may be reached via about 12 miles of unimproved dirt roads from Peterman Hill, at the northwest end of Lucerne Valley. Ord Mountain itself is skirted by unimproved dirt roads and jeep trails. As mines and prospects in the district were active only infrequently during the 1950's, access roads often were in very poor condition, and frequently passable only by jeeps. A small ranch near Aztec Spring, at the north edge of Ord Mountain, is the only permanently inhabited site in the district.

Topography and Drainage

The summit of Ord Mountain is a small plateau which lies almost in the middle of the north-trending backbone of the mountain. In addition to being the summit of the mountain, this plateau also is the most westerly part of a west-northwest trending ridge which lies between Ord Mountain and the north part of East Ord Mountain. From the plateau, which has a maximum elevation of 6,309 feet, the topography drops abruptly on nearly all sides into steep-walled canyons lying between jagged ridges.

Alluvium-covered areas surround Ord Mountain and the low hills to the northwest, and range in elevation from 3,800 to 4,300 feet. Tyler Valley, on the southwest side of the mountain, and Ord Mountain itself are the only topographic features in the district that are named on the U. S. Geological Survey 15-minute quadrangle which encloses the district. Three additional geographic names have been used in this report. These names are "Aztec Valley" (after Aztec Spring), on the north side of Ord Mountain, in the north-central part of the district; and "Mineral Ridge" and "Sweetwater Canyon" (named after Sweetwater Spring), which are on the northwest side of Ord Mountain, in the central part of the district (pl. 1).

The drainage from Ord Mountain extends southward into Tyler and Lucerne dry lakes, northeastward into the eastern part of the Lower Mojave Valley, northward to the western part of the Lower Mojave Valley, and northwestward and westward through Stoddard Valley into Mojave Valley.

Climate, Vegetation, and Water Supply

The arid climate of this region gives rise to a typical assemblage of desert flora: creosote bushes, sage, yucca, grasses, and a few other species. Because the Ord Mountains are higher than the surrounding areas, precipitation on them is markedly higher, reaching about eight inches annually. Snow commonly persists on the ground for many days during the winter. Thunder showers are common during the warmer months. The annual temperature range in the lower elevations is from about 10° to 110° F.

* Prepared partly in partial fulfillment of the requirements for the degree of Master of Arts, Department of Geology, University of California, Los Angeles. Manuscript submitted for publication August, 1960.

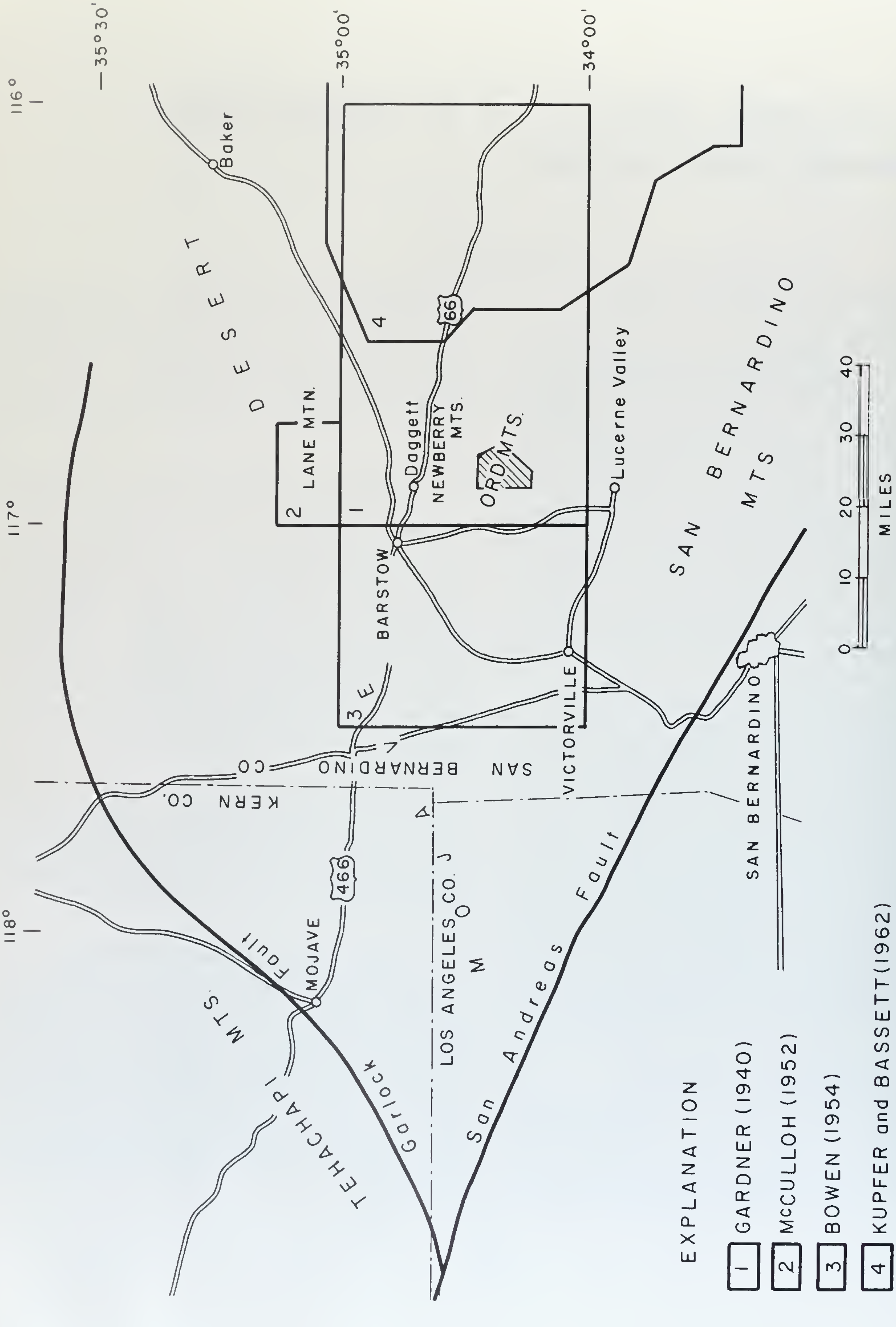
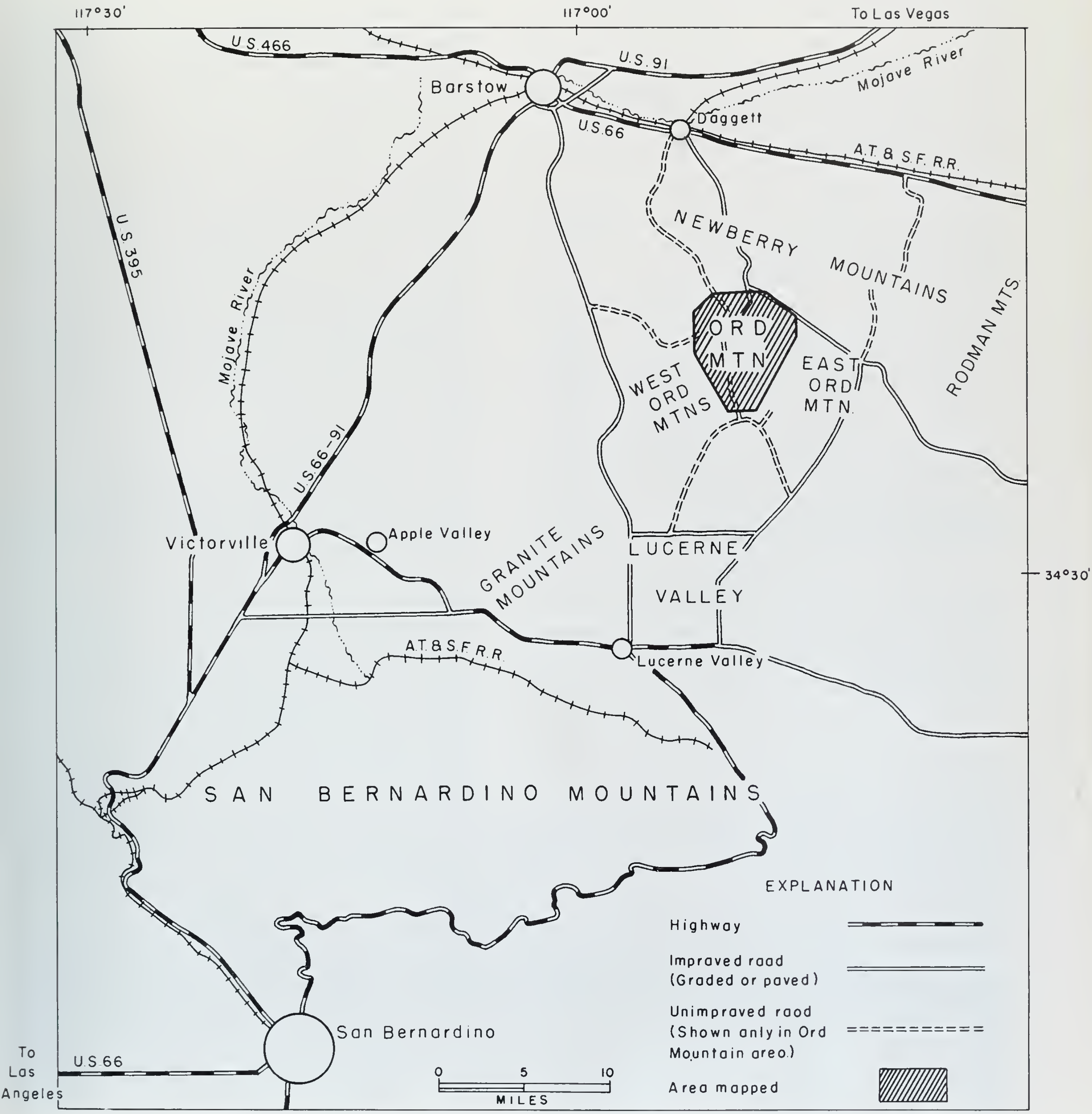


Figure 1A. Index map showing location of the Ord Mountain district.

Figure 1B. Index map showing Ord Mountain district and surrounding region.



Water was found issuing from the ground only in two places during the field work: on Level three of the Rio Vista workings of the Ord Mountain mine, and from a fault exposed in the Last Chance claim tunnel of the Ord Mountain mine. Water was standing at the 4,050-foot elevation in the Brilliant claim shaft.

Following are descriptions of the principal springs and wells:

Aztec Spring. Aztec Spring is about 100 yards southwest of the ranch house in upper Aztec Valley. No data relative to flow were available during the study. The spring was not flowing at the time of the writer's visit in the Spring of 1953.

*Aztec Valley * Ranch Well.* A few hundred yards north of the ranch house a well on the Aztec Valley fault is worked by either mechanical pump or windmill, and furnishes water for the ranch.

Sweetwater Spring. This spring is approximately half a mile south of the Ord Mountain mine camp, in upper Sweetwater Canyon. According to Thompson (1929, p. 500), "A sample proved of good quality for domestic use. It is said the spring can furnish 500 gallons a week." At the time of the writer's visit, the spring was covered.

Willis Well. Willis Well is in a small alluvial basin near granite in the extreme eastern portion of the area and may be reached easily by road (pl. 1). No data on flow were available during the study.

Previous Work

Most of the references to the Ord Mountain district are in reports of the California Division of Mines and Geology that contain descriptions of individual mining properties in San Bernardino County. The earliest of these reports was by H. DeGroot in 1890. He briefly described a few properties and the early history of the district as a source of gold. Later, reports of this type were written by W. B. Tucker and R. J. Sampson (1930, 1943), and by L. A. Wright and others (1953). E. M. Place, a mining consultant hired by the Ord Mountain Mining Company in 1917, wrote a brief unpublished report covering all phases of mining within the claims owned by the company.

The only geologic study to have been published that includes the district was made by D. L. Gardner, and published in 1940; this study comprised a reconnaissance investigation of the Newberry and Ord Mountains. By early 1963, the Ord Mountains and several surrounding quadrangles had been mapped geologically by T. W. Dibblee, of the U. S. Geological Survey, but not published.

Geologic investigations in neighboring regions relate to the geology of the district and are listed in the bibliography. The index map (fig. 1a) shows boundaries of areas in the vicinity of Ord Mountain mapped by Gardner, T. H. McCulloh, O. E. Bowen, Jr., and D. H. Kupfer and A. M. Bassett.

Field Work and Acknowledgments

About 45 days were spent mapping during the period from January to August 1953, and in December 1955 and October 1959. The areal geology was mapped on rather poor vertical aerial photographs which have a scale of approximately 1:20,000. The geology and workings of individual mines and prospects were mapped at a scale of 1:480 with Brunton compass and tape. A topographic map of the Ord Mountains quadrangle, which includes the district, was published by the U. S. Geological Survey and released for distribution in 1956.

D. F. Hewett, of the U. S. Geological Survey, kindly made available aerial photographs of the region. J. L. Carder, formerly associated with the Ord Mountain

* *Note:* Not a formal name.

Figure 2 (below). View north-northeast from Lucerne Valley, across Lucerne dry lake, to the Ord Mountains.

Mining Company, made available company reports and correspondence, and personally added historical data. The helpful suggestions of Drs. Donald Carlisle and Kenneth D. Watson of the writer's masters degree thesis committee at the University of California at Los Angeles are deeply appreciated. The writer also is indebted to Dr. Lauren A. Wright, formerly of the California Division of Mines and Geology, and B. W. Troxel of the Division of Mines and Geology, who carefully reviewed the manuscript. The illustrations were drafted by Miss Doris Mae Weber.

GEOLOGIC FEATURES

The regional geology of this part of the Mojave Desert is featured by complex rock types which are mainly of igneous and metamorphic origin. Continental sedimentary rocks are relatively common in parts of the region, but fossiliferous sedimentary rocks are rare.

The oldest rocks in the Ord Mountain district itself are metamorphosed sedimentary rocks which include (1) feldspathic quartzite, which crops out beneath a small area in the northeast part of the district, and (2) an inclusion of crystalline limestone in hybrid rock. Both of these rocks tentatively are dated Triassic or older. Metavolcanic rocks known as the Ord Mountain Group, and perhaps Triassic in age, were mapped as two units. The older unit, a widespread succession that consists mainly of extrusive andesite and interlayered tuff, and extrusive rhyolite, has been intruded by the younger unit, keratophyre.

A hybrid rock (chiefly quartz monzonite to granodiorite), considered as Jura-Cretaceous(?) in age, has been intruded by granite and biotite granite, also of Jura-Cretaceous age, in the northern and eastern parts of the district. Quartz monzonite is intrusive into the Ord Mountain Group of metavolcanic rocks in the west and southwest parts of the district. Hypabyssal dikes and minor bodies of porphyritic biotite dacite are dated tentatively as Cretaceous(?) to Tertiary(?), and quartz veins and a remnant of relatively recent extrusive brecciated rhyolite-dacite are dated as late Tertiary.

Superficial deposits of older and younger alluvium of Quarternary age cover much of the low area surrounding Ord Mountain.

Triassic (?) or Older Rocks

Feldspathic Quartzite. The oldest rocks in the district consist of thickly layered feldspathic quartzite which crops out as a ridge, south and east of Willis Well, near the eastern border of the area mapped. The layers are very pale to medium gray and consist of fine- to medium-grained crystalloblasts of quartz (80 to 95 percent), feldspar (0 to 10 percent), sericite (3 to 5 percent), and biotite (0 to 5 percent), plus minor and irregularly distributed chlorite, ilmenite-magnetite*, and pyrite. The layering apparently is relic bedding and suggests a total exposed thickness of about 2,000 feet.

These rocks have been intruded by Jura-Cretaceous(?) biotite granite and perhaps by the hybrid rock. They are not in contact with the Ord Mountain Group of Triassic(?) metavolcanic rocks, but are more highly metamorphosed, and for this reason probably are older. Gardner (1940, p. 262) mapped metamorphosed sedimentary rocks of probable Archean age in the Newberry Mountains (fig. 1a) which, from his description, seem to resemble the metamorphosed sedimentary rocks in Ord Mountain.

Results of an analysis of a sample of the feldspathic quartzite, performed by Eisenhauer Laboratories (Dec. 18, 1961), are shown below: **

SiO_2	79.75 percent
Fe	.09
CaO	.45
Al_2O_3	13.88
Na_2O	2.06
K_2O	1.95
Moisture, @ 105° C.	.98
Loss on ignition	.69
Total	99.85

Limestone. A lens of pale buff-gray, fine-grained crystalline limestone (marble) occurs as an inclusion in hybrid rock in the northeast part of the district. The lens is about 300 feet long and may have a maximum thickness of 200 feet. Grouped around it are small bodies of magnetite. Near these bodies, the calcite grains of the limestone are partially replaced by a network of iron-bearing carbonate minerals with subordinate chlorite. Weathering has leached the calcite more easily than the secondary iron-bearing carbonate and has caused the surface of the rock to appear somewhat porous or hackly.

The age of this limestone is not apparent. If the hybrid rock was derived by alteration of Triassic(?) Ord Mountain Group metavolcanic rocks, the limestone would be a primiary lens (as a smaller lens is, which lies 3,000 feet to the southwest, in rocks of undeniable volcanic origin). On the other hand, if the hybrid rock is of igneous origin, the limestone may be a pendant derived from a formation possibly present in nearby areas. Gardner (1940), for example, described limestone portions of metamorphosed sedimentary rocks of Archean age, and undifferentiated marble and quartzite of Paleozoic age, in the Newberry Mountains; and Bowen (1954)

* As used in this report, "ilmenite-magnetite" is either ilmenite, magnetite, or a mixture of the two minerals.

** Analysis furnished anonymously by private company. Locality is approximately the middle of the S½NE¼ sec. 16, T. 7 N., R. 2 E., S.B.M.

Figure 3. View south-southeastward from the Greenback prospect shows the north side of Ord Mountain and the south end of Aztec Valley. Rocks are metavolcanics of the Ord Mountain Group. They dip relatively gently to the west in the ridge in the left part of the photograph, and dip very steeply and are overturned in the area below the skyline in the central part of the photograph.

has described the Oro Grande Series, of Carboniferous age, and the Fairview Valley Formation, of Permian age, both of which contain abundant limestone. These rocks are exposed on the north and west sides of Sidewinder Mountain, about 15 miles southwest of the district.

Triassic (?) Rocks

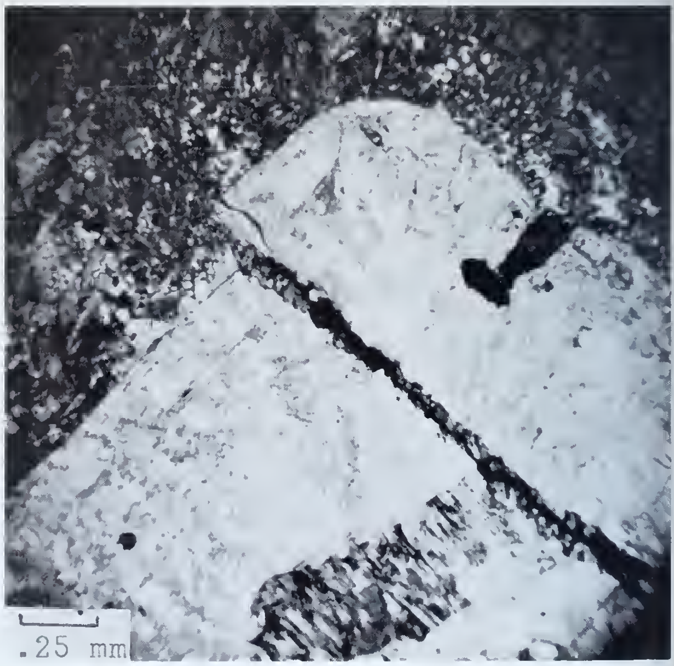
ORD MOUNTAIN GROUP

The name "Ord Mountain Group" was proposed by Gardner (1940, p. 266) for the metavolcanic rocks which comprise nearly the eastern two-thirds of Ord Mountain. The present study has shown that these rocks also crop out in the western part of the district and occur as pendants in hybrid rock. Outside of the district the rocks are found in East Ord Mountain, in the West Ord Mountain area, in the Newberry Mountains (West Kane Mountain area), and in the south end of the Rodman Mountains (Bessemer Mountain).

The writer, like Gardner, divided the Group into two units for the purpose of mapping. The older unit, a series of extrusive rocks, has been intruded by the younger unit, keratophyre, which was called metaporphyry by Gardner.

The extrusive rocks consist of andesite, interbedded basalt and tuff, and rhyolite. The flows are thinly to thickly layered and the tuff beds are thin; the andesite and basalt are dark gray to dark greenish gray, and the rhyolite is generally pale bluish gray on fresh surfaces, and weathers pale orange brown. The keratophyre is blue gray. Rocks of the Ord Mountain Group are extremely resistant to weathering and erosion, especially the keratophyre, which underlies the crest of Ord Mountain, and in which are formed extremely steep-walled canyons just west and south of the summit of Ord Mountain.

Figure 4. Photomicrograph of broken albitized orthoclase phenocryst in spherulitic rhyolite of Ord Mountain Group (polarized light).



Extrusive Rocks

Although the extrusive rocks of this group are shown as undivided on the accompanying map (pl. 1), they can be divided into four distinctive sub-units.

Sub-unit One. The oldest exposed rocks of the Ord Mountain Group are dark gray to dark greenish gray extrusive rocks which are about 3,500 feet thick. They range from andesite to basalt and contain interbedded pale-gray tuff beds from 3 to 10 feet thick which occur at vertical intervals of 300 to 500 feet. This sub-unit is best exposed on the ridge southwest of Willis Well.

The extrusive flow rocks are massive to vesicular and locally amygdaloidal. They are porphyritic, with a very fine-grained holocrystalline groundmass. The feldspar phenocrysts are oriented with their long axes parallel to flow lines. Accessory and secondary minerals present are biotite, magnetite-ilmenite, epidote, and chlorite. Many of the tuff beds contain pyrite, which is partially or wholly altered to hydrous iron oxides and hematite, giving the rock a yellow-brown to reddish-gray mottled appearance on weathered surfaces.

Sub-unit Two. Sub-unit two is massive, resistant spherulitic rhyolite which is found near the center of the eastern flank of Ord Mountain and throughout the area north and west of the White Dollar mine in the northeast part of the district. It overlies sub-unit one (fig. 3). The maximum observed thickness for this sub-unit is about 4,500 feet. The rock is generally pale bluish gray to medium gray, and weathers pale orange brown to dark brown. It is porphyritic, with phenocrysts of feldspar and quartz as long as 5 mm. characteristically elongated parallel to flow lines, and composing 10 to 20 percent of the rock. The orthoclase and plagioclase have been partially to wholly albitized (fig. 4). The groundmass is very fine-grained holocrystalline and commonly contains spherulites. Most of these spherulites consist of radially oriented laths of feldspar, and some have a quartz grain in the nucleus. Phenocrysts of quartz, which compose 5 to 10 percent of the rock, generally have embayed crystal outlines. Accessory minerals are bleached biotite and magnetite-ilmenite.

In the north part of the district, within a half-mile-wide zone along the contact of the unit with hybrid rock, the rhyolite is metamorphosed to an aggregate rich in albite, chlorite, hornblende, and magnetite-ilmenite, and is progressively coarser grained near the contact. In general, within this zone the magnetite-ilmenite content of the rock is proportional to its distance from the contact, ranging from less than one percent in nearly unaltered rocks to perhaps as much as 10 percent in highly metamorphosed rocks near the contact.

A lenticular body of crystalline limestone, which is about 100 feet thick and 200 feet long, occurs in the metavolcanic rocks at a locality about one-half mile east of the Greenback prospect, in the north-central part of the district (pl. 1). The presence of limestone here suggests an underwater environment during extrusion of at least part of the rocks of the Ord Mountain Group.

Moderately to strongly metamorphosed volcanic rocks in the south part of the district mainly resemble the rocks of sub-unit two.

Sub-unit Three. Rocks of this sub-unit consist of dark greenish-gray to dark-gray vesicular andesite which underlies the area that extends north from the summit of Ord Mountain, through the Ord Mountain mine area, to the Aztec Valley fault. They overlie sub-unit two. The andesite characteristically is vesicular and a small proportion of the vesicles contain amygdules of calcite and pink zoisite(?) (thulite?) which are as much as four inches in diameter. Phenocrysts of andesine, which range in length from ½ to one mm., compose from less than one percent to about 10 percent of the rock. The groundmass has a pilotaxitic * texture and consists mostly of (1) flow-oriented grains of andesine which commonly are albitized, and (2) intergranular augite, which is altered to a fine-grained aggregate of hornblende and magnetite. Adjacent to shear zones the rock has a very fine-grained schistose texture. Other common secondary minerals are quartz (0 to 5 percent), calcite (0 to 3 percent), sericite (0 to 1 percent), and epidote (0 to 1 percent). Epidote is common in veinlets as thick as one inch. The thickness of the sub-unit is about 4,500 feet.

Sub-unit Four. Metavolcanic rocks exposed west of the Ord Mountain fault zone, which strikes northward along the west side of Ord Mountain, closely resemble the spherulitic rhyolite described above as sub-unit three. In contrast to those rocks, however, sericitization of the feldspars is more pronounced in samples from the west edge of the area mapped, and albitization seems to be less common. The minimum exposed thickness of the metavolcanic rocks west of the fault zone is about 4,000 feet.

The extrusive rocks have a total minimum thickness of about 16,500 feet, a figure which is only an estimation because, west of the Ord Mountain fault zone, the rocks have been partly assimilated by younger, plutonic rocks and faulting has disturbed the sequence. The contact between the lowest of the Ord Mountain volcanic layers and the older metasedimentary rocks is hidden beneath alluvium, but is assumed to be depositional.

Keratophyre

The keratophyre is a dark bluish-gray, massive, and generally homogeneous rock which comprises two irreg-

* A groundmass that is glass-free, and consists of feltlike, interleaving lath-shaped microlites.

Figure 5A. View north-northwest from a point on road to Moly prospect in S½SW¼ sec. 30. Keratophyre (Trok) of the Ord Mountain Group of metavolcanic rocks has intruded flow rocks (Trov) of the Group. The Moly prospect is in hydrothermally altered zones of the rocks. Hybrid rock borders the volcanics on the west.

ular bodies about 3,000 feet apart. The more southerly one, which is about one square mile in total outcrop area, underlies the summit area of Ord Mountain. The more northerly body, which is slightly less than one square mile in total outcrop area, is exposed along the northwest side of Ord Mountain. The keratophyre probably was derived by deuteric alteration from andesite which was intruded into the extrusive rocks of the Ord Mountain Group prior to emplacement of the Jura-Cretaceous(?) granitic rocks. The intrusive relationships are clearly exposed in the steep-walled canyon west of the summit of Ord Mountain (figs. 5a and 5b).

The keratophyre has a very fine-grained holocrystalline groundmass which contains flow-oriented, subhedral to euhedral crystals of albite from 1 to 3 mm. in length (figs. 6a and 6b). The albite phenocrysts comprise 30 to 40 percent of the rock. Spherulites are common in the groundmass. Other primary minerals are quartz (1 to 5 percent), orthoclase (0 to 3 percent), and pyroxene, apatite, zircon and magnetite, each less than 1 percent. Alteration minerals are hornblende (derived from pyroxene, 1 to 3 percent), sericite (less than 1, to 3 percent), and epidote (0 to 5 percent).

The rock owes its extreme resistance to weathering to the following three factors: dense fine-grained texture; extreme resistance to hydration of its primary mineral constituent—albite; and a dearth of easily-weathered ferromagnesian minerals.

Figure 5B. View east from ridge west of Ord Mountain summit shows intrusive contact of keratophyre (R̄ok) with vesicular andesite (R̄ov).

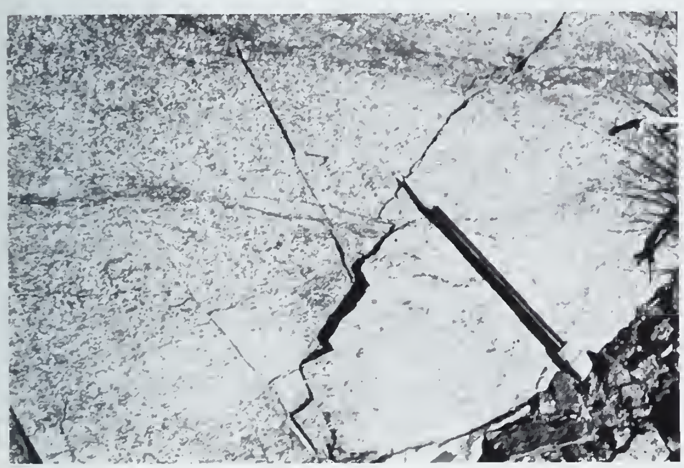
Age and Correlation

The probable Triassic age for the Group was suggested by Gardner (1940, p. 270) who stated:

> "The age of the Ord Mountain group is fixed as pre-late Jurassic(?) for rocks of the group are intruded by Jurassic(?) plutonics. The possibility of an Archean age can be eliminated, for the rocks lack the high degree of metamorphism characteristic of the Archean rocks, not only within this region, but in surrounding parts of the Mojave Desert. The possibility of a Paleozoic age can virtually be eliminated, for none of the Paleozoic sections in the surrounding regions show any indications of volcanic activity.
>
> The group is considered to be either Triassic or Jurassic in age."

Bowen (1954) described the volcanic rocks of the Sidewinder Series in the Barstow quadrangle as akin to Gardner's Ord Mountain Group. The Ord Mountain Group and the Sidewinder Series were correlated by Gardner and Bowen respectively with like rocks in the Santa Ana Mountains in Riverside County, and in San Diego County. Rhyolite observed by the writer in exposures in the San Ysidro Mountains of San Diego County closely resembles that of sub-unit four of the rocks in the Ord Mountain district.

Figure 6A. Keratophyre. View of outcrop on ridge about ¼ mile east of Moly prospect, in south part of district. Rock has a distinct bluish cast.



Jura-Cretaceous (?) Rocks

HYBRID ROCK

A hybrid or heterogeneous rock, most of which has the appearance of a plutonic rock of the range of quartz monzonite to granodiorite, is exposed widely in the north part of the district (fig. 23a) and along the west side of Ord Mountain. The unit underlies about 5 square miles. Its outcrops are moderately resistant to erosion and weather dull pale brown to dark brown; fresh surfaces range from pale gray to dark greenish gray.

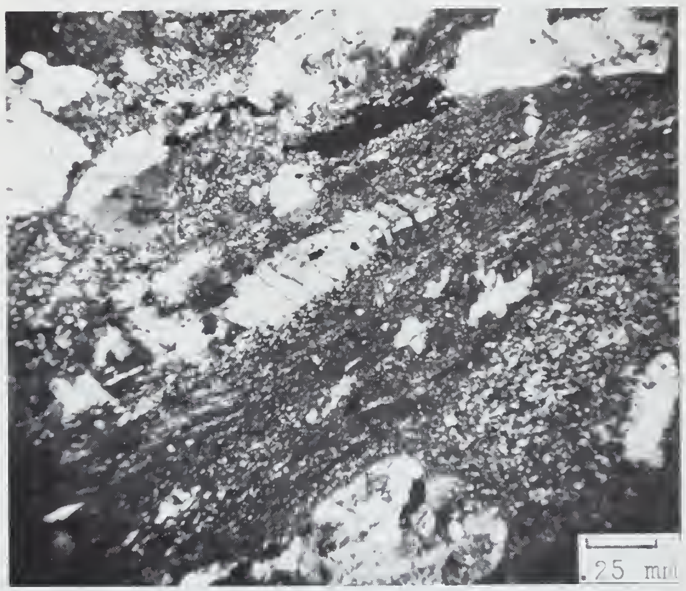


Figure 6B. Photomicrograph of keratophyre of Ord Mountain Group shows flow-oriented and micro-faulted lath of albite (elongated light-colored crystal in center) in very fine-grained groundmass. Most of the other phenocrysts are also albite (polarized light).

The rock comprises a very fine- to coarse-grained aggregate which consists of assemblages of many minerals, but principally andesine (An 32-38; 0-80 percent?), albite (less than 20 to 85 percent?), orthoclase (0 to 35 percent?), quartz (5 to 25 percent), brown biotite (0 to 5 percent), and hornblende-actinolite (2 to 5 percent). The grains are as long as 7 mm., and nearly all are corroded and embayed because of recrystallization and replacement. It is presumed that where albite occurs, it formed as the result of replacement of andesine and orthoclase after the original crystallization of the rock. Other minerals present include green biotite, which has formed by alteration of brown biotite; penninite (less than 1 or 2 percent); rutile(?) (less than 1 percent); epidote (as much as 5 percent); apatite and zircon (less than 1 percent); sericite (0 to 4 percent), which occurs as feathery aggregates which have partially replaced andesine; magnetite and ilmenite; and aggregates of calcite and grossularite in veinlets which cut all other minerals. Parallel orientation of grains of mafic minerals is uncommon.

The hybrid rock contains masses of the Ord Mountain Group metavolcanic rocks which are as much as one mile long and 1,000 feet wide, some showing sharply gradational contacts with the hybrid rock. This relationship suggests that the hybrid rock was intrusive in origin. Indeed, in general appearance many parts of the rock resemble the biotite quartz monzonite exposed in the west part of the district. However, the partial to whole alteration of primary minerals and the corrosion of crystal boundaries of the hybrid rock have veiled its original texture. The present assemblage of minerals and textures suggests that it may be the result of relatively intense deuteric alteration during a late magmatic stage or perhaps of contact metasomatic alteration during a post magmatic stage.

Whatever the origin of the hybrid rock, it is younger than the masses of Triassic(?) metavolcanic rocks of the Ord Mountain Group which it contains; and it is older than bodies of Jura-Cretaceous(?) granite which intrude it.

GRANITIC PLUTONIC ROCKS

Plutonic rocks, silicic to intermediate in composition, occur in widely distributed bodies of various sizes around the base of Ord Mountain. The rocks have been subdivided into three types: biotite quartz monzonite, biotite granite, and fine-grained granite. As the rocks were not observed in contact with one another, their relative ages were not determined.

Biotite Quartz Monzonite

The most characteristic plutonic rock in the region is porphyritic, medium- to coarse-grained biotite quartz monzonite. Small, elongated bodies of the rock clearly are intrusive into Ord Mountain metavolcanic rocks in the area along the west edge of the northwest part of the district (pl. 1). Bodies of the rock that intrude metavolcanic rocks increase in size to the south; and in the southwest part of the district, west of the Tyler Valley fault, nearly all bedrock consists of biotite quartz monzonite.

Typically the rock is porphyritic, containing phenocrysts of pink orthoclase as much as 2 cm. in length. Dark schlieren that range from a few inches to several feet in length are common. Fresh exposures of the rock have a pale greenish-gray color because of its mafic mineral content, and it weathers to rounded, pale-brown, knob-like exposures.

The primary minerals are orthoclase (20 to 40 percent), oligoclase (An 26-32; 25 to 40 percent), quartz (10 to 35 percent), biotite (2 to 5 percent), hornblende (0 to 4 percent), and apatite, sphene, zircon, and ilmenite-magnetite, each less than 1 percent. The secondary minerals are: sericite (1 to 5 percent) and albite, which partially replace orthoclase and oligoclase respectively; penninite (1 to 3 percent), leucoxene (1 to 2 percent), and epidote (less than 1 percent), which replace biotite; hornblende, which occurs as feathery aggregates in veinlets; and ilmenite, which commonly has replaced entire crystals of sphene.

Gardner (1940, p. 270) identified the rock as hornblende quartz monzonite, and Bowen (1954, p. 65) recognized a similar biotite quartz monzonite in the Barstow quadrangle. Dikes of basalt and rhyolite commonly cut the rock in the Ord Mountain district.

Biotite Granite

Biotite granite is the least extensively exposed of the three plutonic rocks. Seven small bodies that total no more than a few thousand square feet in exposed area have been intruded into metavolcanic rocks in the extreme north part of the district; and the largest body of biotite granite in the district, about one-half of a square mile in total area, surrounds Willis Well in the southeast part of the district. Exposures at Willis Well are pale yellow-brown and thoroughly weathered, whereas those to the north are relatively unaltered.

The rock superficially resembles the biotite quartz monzonite in appearance. However, the characteristic porphyritic texture of the quartz monzonite was not observed in this rock, and schlieren are rare. The texture is hypautomorphic granular, and medium to coarse grained. In thin sections of rocks showing alteration, corroded crystal boundaries are common. Primary minerals are orthoclase (35 to 40 percent), andesine-oligoclase (An30; 15 percent), quartz (40 to 45 percent), biotite (2 to 5 percent), hornblende (0 to 4 percent), and less than one percent each of zircon, apatite, sphene, and ilmenite-magnetite. Orthoclase has partially altered to albite, andesine-oligoclase to sericite (0 to 1 percent), and biotite to penninite (0 to 1 percent) and leucoxene (0 to 1 percent). This granite is remarkably similar to the granite that Gardner (1940, p. 273) mapped south of the district and correlated with the Cactus granite of Vaughan (1922).

Fine-Grained Granite

Fine-grained, buff-colored granite, which has a very homogeneous composition and texture, occurs as two intrusive bodies: one in the northwest part of the district, and the other in the center of the northeast part. Each body is less than one-quarter square mile in total area.

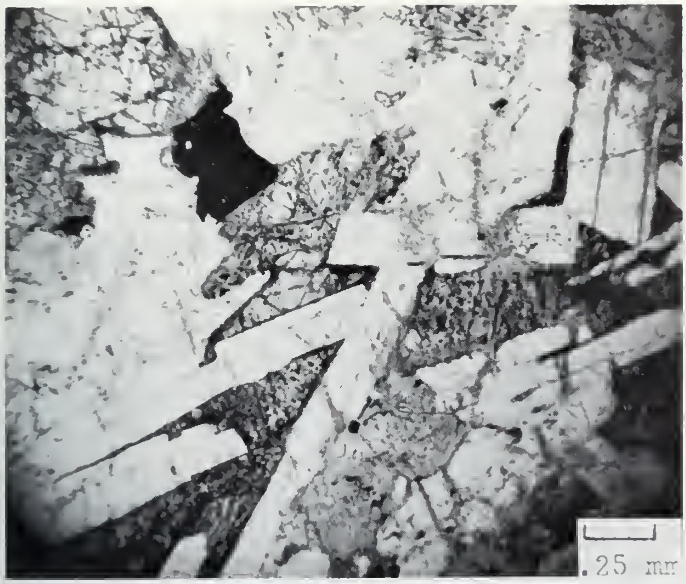


Figure 7. Photomicrograph of diabase showing laths of andesine (light colored) surrounded by uralitized anhedral diallage (dark-colored) and secondary ilmenite-magnetite (very small opaque crystals) (ordinary light).

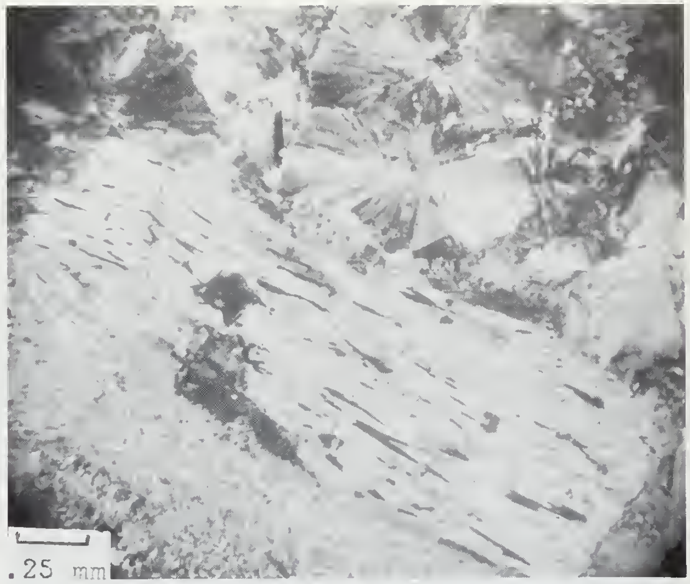


Figure 8. Photomicrograph of spherulitic rhyolite showing crystal of biotite bordered on upper right and upper left by spherulites in groundmass (polarized light).

In thin section the rock is seen to have an hypautomorphic granular texture and to be composed of the following primary minerals: orthoclase (45 percent), andesine (An 34, 15 percent), quartz (40 percent), and biotite (1 percent). The potash feldspar has been partially albitized and the plagioclase partially sericitized. The biotite is partially altered to penninite and leucoxene. Apatite and magnetite-ilmenite are the minor accessory minerals. Corroded crystals are common. Maximum grain size is about 2 mm; and the average is about 1 mm. This granite is unlike the granite described by Gardner (1940, p. 272) in the Newberry and Bristol Mountains to the northeast, as that rock has a distinct reddish tinge. Nor does it seem to resemble any of the plutonic rocks described by Bowen in the Barstow quadrangle.

Age and Correlation

Recent lead-alpha age determinations by Jaffe and others (1959, p. 84-89) have indicated that the granitic rocks of the Mojave Desert are about the same age as the batholith of southern California, which is Cretaceous. The age determined by Jaffe and others for the sample collected nearest the Ord Mountain district—granite from the south end of the Granite Mountains—is 116 million years. For this report, however, because of the paucity of published ages for the variety of intrusive rocks of the region, it seems best to date the granitic rocks of the Ord Mountain district merely as Jura-Cretaceous(?). This age includes the Jurassic gap between the Cretaceous age of Jaffe and others and the age of the next oldest rocks of the district, metavolcanic rocks of the Ord Mountain group, which are Triassic(?).

Cretaceous-Tertiary (?) Rocks

All rocks within the Ord Mountain district, except quartz veins, rhyolite-dacite flow breccia, and alluvial sediments of Recent age, have been cut by a relatively complex system of dikes and irregular bodies of rocks of hypabyssal origin. The most prominent of these have been mapped (pl. 1), including mainly those exposed on the low ridge surrounded by alluvium in the extreme western part of the district and in hybrid rock exposed east of the White Dollar mine. Five distinct units were recognized by age, composition, and texture. These consist of diabase, spherulitic rhyolite, rhyolite, basalt, and porphyritic biotite dacite.

DIABASE

A northwest-trending dike of partly altered dark greenish-gray diabase crops out along the low ridge on the west edge of the area mapped. The dike is about 200 feet long. The rock has a diabasic texture which is fine- to medium-grained (fig. 7). Prior to its alteration, the rock was composed of about 60 percent andesine (An36-44), which occurred as euhedral laths, and 40 percent diallage, which was interstitial to the andesine, Apatite (less than 1 percent) is the only accessory mineral. The andesine has been partly altered to sericite (5 percent), and about four-fifths of the diallage has been altered to uralite (which consists of fine-grained decussate aggregates of blades of actinolite, with subordinate proportions of ilmenite-magnetite, leucoxene, epidote, and a carbonate mineral). The dike has been truncated by a fault which has been filled with a hydrothermal quartz vein.

SPHERULITIC RHYOLITE

Bordering the diabase dike on the east is a gray spherulitic rhyolite dike, approximately 2,500 feet long and ranging in thickness from 10 to 30 feet. Commonly the rock has a very fine-grained hypautomorphic granular groundmass in which spherulites are common (fig. 8). The groundmass makes up 60 percent of the rock. Phenocrysts include orthoclase (55 percent), oligoclase-andesine (An28-34, 25 percent), and quartz (20 percent); they range in length from 0.5 to 4 mm. The subordinate primary minerals are biotite (1 percent), and zircon and apatite, each less than 1 percent. Secondary minerals include sericite (3 to 4 percent), quartz (1 percent), and leucoxene (less than 1 percent).

BASALT AND RHYOLITE DIKES

North- to northwest-trending dikes of basalt and rhyolite occur throughout the district. They range in thickness from 1 to 25 feet and in length from a few tens to several thousand feet. The rhyolite dikes are about five times more numerous than those of basalt. The dikes commonly occur in clusters of two to four, and, where age relationships were observed, the rhyolite cuts the basalt.

The basalt is typically dark gray to dark greenish gray and much of it is distinctly schistose. Phenocrysts of sericitized plagioclase comprise as much as 10 percent of the rock. Pyroxene phenocrysts have been altered to actinolite which in turn has been partly or wholly altered to an aggregate of chlorite, leucoxene, and epidote. The groundmass makes up about 60 to 70 percent of the rock and has a hyalopilitic * texture. Albite is a late secondary mineral which forms veinlets.

The rhyolite commonly is pale gray on fresh surfaces which weather pale brownish gray. One thin section examined shows a very fine-grained holocrystalline groundmass which contains phenocrysts of highly sericitized and albitized feldspar, chloritized and epidotized mafic minerals, and quartz. Leucoxene occurs in very small proportions. The groundmass comprises about 70 to 80 percent of the rock.

PORPHYRITIC BIOTITE DACITE

Perhaps the freshest appearing intrusive rock in the district is porphyritic biotite dacite. It contains medium- to coarse-grained phenocrysts of pale-gray andesine (An30-38) and pale-pink orthoclase which stand out in relief against the medium-gray groundmass on weathered surfaces. The rock forms three dikes, four bodies that are somewhat ovoid in plan, and one wedge-shaped body. The most prominent of these masses is a north-trending dike which is about 1,200 feet long and 150 feet wide. It is exposed on the low ridge in the west-central part of the district.

* A groundmass that consists of needlelike microlites in glass.

The primary minerals in this rock are andesine (35 to 45 percent), orthoclase (5 to 10 percent), quartz (5 to 20 percent), biotite (15 percent), hornblende (2 to 5 percent), and sphene, apatite, and magnetite-ilmenite, each less than 1 percent. Common alteration minerals in the rock are sericite, albite, quartz, epidote, and chlorite. The groundmass comprises 40 to 60 percent of the rock and is composed of very fine-grained holocrystalline sheaths of microlites of feldspar.

QUARTZ VEINS

Hydrothermal quartz veins that commonly contain copper minerals are abundant throughout the district. See the section of the report on mineral deposits for further discussion of the veins.

Late Tertiary Rocks

RHYOLITE-DACITE FLOW BRECCIA

On the west side of Aztec Valley, in the extreme northern sector of the district, a remnant of a volcanic flow, which is ovoid in plan, rests on hybrid rock and granite. This remnant, which strikes northwest and dips 3° to 6° east, is about 100 feet thick. It consists of a breccia composed of multi-colored crystal and lithic fragments set in a brick-red, very fine-grained groundmass which comprises about 30 percent of the rock. The brick-red color is derived from interstitial secondary iron oxides. Fragments range from less than 1 mm. to as much as 1 cm. in their longest dimension. The lithic fragments appear to have the same composition as the combined crystal ones in the groundmass. The primary minerals of the fragments are orthoclase, plagioclase, quartz, magnetite-ilmenite, and zircon. The plagioclase has been partly sericitized. A similar extrusive dacite in the Barstow quadrangle was described by Bowen (1954, p. 85-86), who dated it as Pliocene.

Quaternary Rocks

OLDER ALLUVIUM

Two large and dissected remnants of alluvial fans are exposed in the low hills east and west of northern Aztec Valley. The prevailing constituents are angular fragments of multi-colored volcanic rocks which appear to be relatively recent, but bedrock which is correlative with these fragments was not seen by the writer in the Ord Mountain district. The deposits also contain fragments of blue-gray limestone and granitic rocks.

DISSECTED RECENT ALLUVIUM

Dissected alluvium of Recent age is confined largely to the area immediately northeast of the Aztec Valley fault, in the extreme north part of the district. Dissected alluvium can be distinguished from older alluvium by its lack of large fragments. The two units are not in contact.

UNDISSECTED RECENT ALLUVIUM

Alluvium containing rock fragments that range from sand-size to boulders more than four feet in maximum dimension has been deposited in the area that surrounds Ord Mountain.

Structural Geology

REGIONAL STRUCTURAL SETTING

The Ord Mountains are in the central part of the Mojave structural block which has been defined by Hewett (1954, p. 16) as "that part of the Mojave Desert region that lies between the San Andreas fault on the southwest and the Garlock fault on the north." The principal structural trends of the Ord Mountain district and the region around it are northwesterly, and the region is cut by many northwest-trending faults. Within the district the predominant trend of the layering of the metavolcanic rocks and the trend of dikes is northwesterly. The absolute ages or age of the faulting and tilting has not been determined.

TILTING

The extrusive volcanic rocks of Triassic(?) age, which have a minimum estimated thickness of about 16,500 feet, are homoclinal in structure. The stratigraphic top is assumed to be to the west, simply because the dips are predominantly to the west. No evidence was seen in the field for determining the top. The extrusive rocks commonly strike about N. 20° W. and range in dip from about 60° west at the lower elevations, in the north-central part of the district, near the White Dollar mine, to 80° to 85° overturned to the east near the summit of Ord Mountain.

Most of the tilting probably occurred before emplacement of the plutonic rocks, of Jura-Cretaceous(?) age, as these rocks do not appear to be markedly deformed.

FAULTING

Two periods of faulting can be recognized in the district. One period occurred prior to formation of the hydrothermal quartz veins, and the other after formation of the veins.

Pre-Mineralization Faulting. The principal focus for mineralization in the Ord Mountain district is the Ord Mountain fault zone, which trends northward along the west side of Ord Mountain (pl. 1). Several faults outside of the zone also are mineralized.

The Ord Mountain zone consists principally of faulted segments ("ledges") of a main mineralized shear zone, which is accompanied by much shorter, adjacent and branching companion shear zones. Near its southern end the fault zone apparently consists of a north-trending, weakly mineralized zone of about one-eighth square mile which consists of shattered and sheared rocks. Both the southern and northern ends of the zone do not seem to be clearly defined: the south end may consist of an apparently weak fault in the NW¼ sec. 31; and the north end was not identified to the north of the Aztec Valley fault.

Vertical displacements on the faults of the Ord Mountain zone were not determined, but right lateral horizontal separation of the contact between keratophyre and hybrid rock along the Coupon Ledge fault, just west of Ord Mountain summit, totals at least 1,000 feet. Slickensides in the Coupon Ledge suggests lateral movement. The age of the pre-mineral faults is younger than Jura-Cretaceous(?) (the age of the hybrid rock), and older than middle or late Tertiary (the age of mineralization). The geometry of the zone is described in the section of this report entitled "Ord Mountain fault zone system of veins."

Post-Mineralization Faulting. Since the hydrothermal deposition of minerals in the Ord Mountain fault zone, the rocks of the district have undergone intensive faulting. At first glance (pl. 1) there does not seem to be any set pattern to the post-mineral faults; however, a radial plot of the strikes of the faults shows two principal systems. The faults of one system strike N. 30°-60° W. and are the more common and the stronger; those of the other system strike generally northeast, but are not nearly as persistent in lateral extent as those of the northwesterly system. No age relationship between the two systems could be determined by the writer. The faults cut all rocks older than Recent alluvium; however, faults that can be traced across Quaternary older alluvium are expressed only by minor crushed zones and apparently do not offset these deposits.

Following are descriptions of the four major post-mineral faults in the district: the Tyler Valley fault, the Aztec Valley fault, the Mineral Ridge fault, and a fault that cuts Ord Mountain summit.

(1) The Tyler Valley fault, the most persistent fault in the district, separates Ord Mountain from the low foothills and valleys to the west. It strikes N. 25°-30° W. and dips from 80° west to vertical. Displacement along it probably is mainly vertical, as no lateral offset could be determined from exposures in the district. The only evidence for the direction of throw is the difference in the elevation between the lower area west of the fault and the higher area east of the fault.

(2) The Aztec Valley fault, which cuts through the northwest and north-central parts of the district, along the southwest edge of Aztec Valley, strikes N. 55° W. and apparently is nearly vertical. In the northwest part of Aztec Valley this fault shows a 400-foot right lateral separation of a contact between granite and hybrid rock.

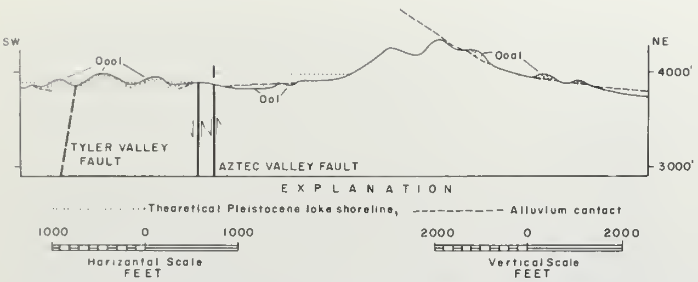


Figure 9. Generalized cross section through the north part of the district shows relationship between old erosion surface, a reconstructed, theoretical Pleistocene lake shore line, and the Aztec Valley and Tyler Valley faults. Lake line may have been dropped on southwest side of Aztec Valley fault relative to northeast side.

Farther to the southeast, offset along this fault is obscured because rocks along it are partly covered by alluvium.

Age relationships between the Tyler Valley fault and the Aztec Valley fault were not determined because the point where they probably intersect lies under older alluvium. Recent vertical offset of a possible Pleistocene lake shoreline, which is exposed on both sides of the Aztec Valley fault, suggests that it is the younger of the two faults.

(3) The Mineral Ridge fault transects Mineral Ridge near the center of the Ord Mountain mine. It strikes N. 25°-30° W. and dips 70°-80° west. This fault shows a 400-foot separation of the east-dipping Sunset Ledge. As a right lateral separation of a west-dipping rhyolite dike also is shown, the principal displacement is assumed to be strike slip.

(4) An unnamed north-northeast trending fault, which is slightly more than 2½ miles long, cuts across the west part of the summit of Ord Mountain (pl. 1). The fault dips steeply to the east. The apparent horizontal separation along the fault of the contact between layered volcanic rocks and intrusive keratophyre, of the Ord Mountain Group, suggests that the eastern side of the fault has moved upward with respect to the western side.

Geomorphology

The dominant topographic feature of the Ord Mountain district is the steep-sided, plateau-like summit of Ord Mountain. This feature owes its prominence to the extreme resistance to weathering and erosion of its underlying rock unit, which is keratophyre of the Ord Mountain Group. Extrusive volcanic rocks of the Ord Mountain Group also are very resistant, but coarse-grained hybrid rocks which underlie the low hills in the northern part of the district and the west side of Ord Mountain are only moderately resistant.

The contact of the older alluvium on an old surface which is underlain by hybrid rock and granite is shown in cross section in figure 9. Although rock fragments of the older alluvium are foreign to bedrock in the district, a large proportion of the fragments resemble Tertiary volcanic rocks in the Newberry Mountains, a few miles to the northeast. The older alluvium probably is a remnant of a once widespread fanglomerate left isolated following fairly recent regional(?) uplift and subsequent erosion.

Aerial photos of the north part of the district show nearly level lines on slopes which are underlain by older alluvium and hybrid rock (pl. 1). These lines are composed partly of caliche and possibly comprise relic segments of a shoreline (or shorelines) of a small lake (or lakes) which once existed in the north part of the district and perhaps to the north of the district. West of the Aztec Valley fault, the line is about 3,900 feet above sea level. East of the fault, the very faint trace of a line can be seen on the east slope of Aztec Valley, at an elevation of about 4,000 feet. The lake probably was enclosed in a relatively small basin, which has been destroyed by erosion.

GENERAL SETTING AND DISTRIBUTION OF THE MINERAL DEPOSITS

The principal mineral deposits of the Ord Mountain district occur along the northwest, west, and southwest flanks of Ord Mountain (pl. 1). These deposits consist of hydrothermal fissure veins which have been developed and mined primarily for copper and gold. Additional groups of veins, but which are largely unproductive, lie in the northwest, north-central, northeast-central, and extreme south parts of the district. The principal mining property in the district is the Ord Mountain copper-gold mine, which comprises a north-trending group of claims about 2 miles long on the northwest flank of Ord Mountain. To the south and south-southwest of this mine lie the Painsville gold-copper mine, the Moly gold-copper prospect, the Mary Etta prospect, and the Red Hill copper-molybdenum prospects. The Martha lead-silver prospect is in the northwest part of the district; the Gold Banner mine is slightly east of the north part of the Ord Mountain mine; and the Greenback copper prospect is slightly less than one mile north of the Gold Banner mine. Two deposits that are contact metasomatic in origin, the White Dollar tungsten deposit and the Ord Mountain iron deposit, lie about 3,000 feet apart in the northeast corner of the district.

None of the deposits in the district was being mined during 1960-61, but exploratory work was being carried out in largely undeveloped deposits in the south part of the district.

HISTORY OF MINING

The first mining claims in the Ord Mountain (or Ord) district are said to have been located in 1876 by Sandie

Lochery, who named them collectively the "Ord group." The group was supposedly named for General E. O. C. Ord, under whom Lochery apparently had served. Nine of the original fourteen claims were patented in 1882 by a Mr. Andrew of the Painsville Company, one of the early developers of the group (J. L. Carder, oral communication, 1955). A few years later Andrew sold his holdings, with the exception of the Painsville claim at the south end of the property, to J. L. Osborne of Daggett. Since that time the two properties have been known separately as the Ord Mountain (or Ord) copper mine and the Painsville mine. Although production records for the early years of mining in the district are not known, output is believed to have been small. In 1890, DeGroot (p. 528-529) stated that "Ord has not produced much bullion, only one small mill having ever been erected there; nor has the population ever been large."

In 1898 the Greenback prospect was opened; and during 1908 and 1909, about 500 tons of gold-silver ore was shipped from the Ord Mountain mine by the Hansen Brothers Company, of Los Angeles, and the Ord Mountain Gold Mining Company, of Daggett.

As a result of increased copper prices during World War I, interest in the district was revived briefly. In 1916, Frank Werner, of Los Angeles, acquired ownership of the Ord Mountain mine and employed a consultant, E. M. Place, to examine the property. In 1917, Werner leased the mine to the Saint Joseph Lead Company which, under the direction of J. L. Carder of Los Angeles, began development work which included driving a crosscut adit and appended drifts on the Central claim. This work terminated in 1925, apparently because of a misunderstanding within the management of the company. Then an attempt was made to lease the property to the United Verde Extension Mining Company, and although the company's examining geologist is said to have thought the property had a "few good shows", he turned it down. The only real mining done in the district during World War I was at the Gold Banner mine, where several hundred tons of gold ore was produced.

The district was largely inactive from 1925 to 1942, when the Ord Mountain mine was reopened by H. J. Stevenson. During 1942, Stevenson mined about 1,000 tons of copper-gold-silver ore from the Rio Vista and Brilliant claims of the property. Mining was discontinued in the latter part of 1942, and development work continued into 1943. A few years later the White Dollar tungsten deposit was opened. This deposit was worked sporadically until 1953, although total output probably was no more than a few hundred tons of ore. Also in 1953, the Martha prospect was developed in a small lead-silver deposit by L. C. Coltrane of Baldwin Park. In July 1956, the Nipissing Mining Company of Canada undertook a brief exploration program at the Ord Mountain mine. During the period 1957-1961 exploratory work was carried out in the southern part of the district: at the Moly copper-gold prospect and adjacent areas by J. A. Thiede, of South Gate, and Fred Holmes, of Highland Park; and in the Red Hill copper-molybdenum deposits by Leonard Shouse, of San Marino, and associates.

Table 1. Recorded mineral production of the Ord Mountain district from 1880 to 1959.

Mine	Year	Reported production*
Gold Banner mine (Copper, gold, silver)	1917	"Several hundred tons"
	1941	"One car"
	1957	Small tonnage†
Greenback prospect (copper)	----	None
Martha prospect (lead, silver)	----	None
Moly prospect (copper, gold, silver)	----	None
Ord Mountain mine (copper, gold, silver)	----	
Brilliant claim	1942	80 tons
Josephine claim	1942	35 tons
Rio Vista claim	1908-09	About 500 tons†
	1942	1,000 tons
Red Hill prospects (copper, molybdenum)	----	None
White Dollar mine	1951-52	About 100 tons†

* Figures from records of U. S. Bureau of Mines and a report by Wright and others, 1953.
† Figures of the U. S. Bureau of Mines are generalized to conceal exact production of individual operators.

SUMMARY OF THE MINERAL PRODUCTION

Published production figures for the Ord Mountain district are very sparse. The periodic reports of the California State Division of Mines and Geology give only sporadic accounts of ore shipments. Available production figures for the district are shown in table 1.

HYDROTHERMAL FISSURE VEIN DEPOSITS *

General Features

The fissure veins of the Ord Mountain district occur principally in five systems or groups. Of these systems, the most extensive and most productive is the Ord Mountain fault zone system, which extends northward along the west side of Ord Mountain for nearly four miles. This system essentially comprises several faulted segments ("ledges") of a main mineralized shear zone and its companion zones, which either branch from the main zone, or are closely parallel to it. The zones range in

* The term "fissure vein", as used in this report, denotes a hydrothermally mineralized fracture or fracture zone which consists of one or more component veins.

width from about 5 to 25 feet. The four additional groups of veins, which are largely unproductive, occur in the northwest, north-central, northeast-central and extreme south parts of the district; veins of these four systems occur chiefly in joints. Additional hydrothermal mineralization in the district occurs as isolated quartz veins and in rhyolite dikes.

The principal metals that have been sought from fissure veins of the district are copper and gold; additional metals that have been sought from one or more localities include tungsten, molybdenum, lead, and silver. The more common ore minerals are chrysocolla, chalcopyrite, chalcocite, pyrite, and bornite; common gangue minerals, in addition to quartz, are barite, epidote, fluorite, and hydrous iron oxides; the most common wall rock alteration minerals are quartz, chlorite, albite, and sericite. The veins cut all rock types of the district except biotite granite, porphyritic biotite dacite, and rhyolite-dacite breccia. Offset of veins along faults is rarely more than several scores of feet.

General Character and Structural Features of the Veins

ORD MOUNTAIN FAULT ZONE SYSTEM OF VEINS

The fissure veins of the Ord Mountain system occur in a zone of faults which trends almost due north along the west side of Ord Mountain for at least 16,500 feet, and perhaps 19,500 feet or more (pl. 1, figs. 10 and 11). The system essentially comprises the Brilliant Ledge *

* Ledge is an archaic and colloquial miner's term which, as used herein, is synonymous with fissure vein. The fissure veins of the Ord Mountain district were named "Ledges" many years ago, and the term is used in this report to conform to local usage.

Figure 10. View east-southeast of the west side of Ord Mountain, showing part of the general trace of the copper- and gold-bearing Ord Mountain fissure vein system.

(on the north), and the Coupon and Painsville Ledges (on the south). Two principal companions of the Brilliant Ledge, from which they branch south-southwest and south-southeast respectively, are the Sunset and Last Chance Ledges. Also a companion of the Brilliant Ledge, but not connected to it, is the Josephine Ledge. South of the Coupon and Painsville Ledges lies an irregular zone, of about one-eighth of a square mile, of highly fractured, sheared and hydrothermally mineralized rocks, which probably also is part of the system; and to the south of the fractured zone, lies a weakly mineralized fault zone which may represent the most southerly part of the system.

The north end of the Ord Mountain fissure vein system is truncated and apparently terminated by the Aztec Valley fault. A series of narrow veins jutting a few hundred feet to the northwest of this fault may be the northern extension of the system, but differences in dip, mineralogy and thickness of the veins make this situation

Figure 11. West side of Ord Mountain. View southeastward. Coupon Ledge trends northward along side of mountain about on level of dump shown near left edge of photograph. Dump is part of the Painsville mine. At right edge of photograph the Ledge is exposed poorly in the gap between the long ridge and the small peak. The Painsville Ledge trends northward along the mountain side below the small peak. Dark rocks above Coupon Ledge are meta-andesite (Trov) of the Ord Mountain Group; lighter-colored rocks below are hybrid rock (hyb). Small Peak is composed of keratophyre (Trok) of the Ord Mountain Group.

Table 2. Structural characteristics of the individual fissure veins of the Ord Mountain fault zone system of veins.

Fissure vein	Length (in feet)	Strike	Dip (vertical range)	Estimated average thickness of fissure vein (in feet)
Brilliant Ledge	6100	N.10°W.	70°-85°W.	15
Coupon Ledge	8300	N.5°-10°W.	70°-85°W.	25
Josephine Ledge	1500	N.25°E.	80°±5°W.	15
Last Chance Ledge	2200	N.15°W.	70°-80°W.	25
Painsville Ledge	4500	N.15°E.	80°W.	5-10
Sunset Ledge	2100	N.20°E.	70°-85°E.	15-20

seem unlikely. The south end of the system is even less definite, and was not determined exactly by the writer.

The fissure veins of the system are commonly offset by minor faults, and the only well-defined major dislocation is along the Mineral Ridge fault in the north part of the system. Right lateral strike separation of the Sunset Ledge along that fault is about 400 feet. Offsets of veins of the south part of the system also may be as much as several hundred feet, but such offsets are not as clearly defined as those of the north part.

The more important data in regard to the structural features of the six major fissure veins are shown in Table 2. As shown, the strike of individual veins is relatively uniform, but the attitude of most of the veins changes gradually along the dip. Thus, most veins, where exposed in shafts or winzes, curve downward or even undulate (fig. 23b). Whether these curves and undulations were formed before or after deposition of vein material was not determined.

The fissure veins, which range in thickness from 5 to about 25 feet, consist of (1) individual, component veins that range in thickness from a few inches to several feet, (2) zones of closely spaced veinlets separated by mineralized host rock (figs. 12 and 13), and (3) large bodies, 10 to 20 or 25 feet in thickness, of nearly solid hydrothermal minerals. The fissure veins themselves generally pinch and swell very gradually, but their component veins and bodies commonly terminate abruptly. Of the large bodies mined, most have been found in the Coupon Ledge of the Rio Vista workings (pl. 2) of the

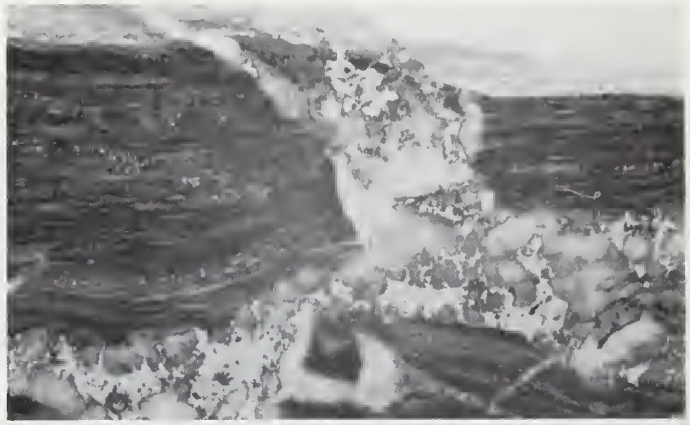


Figure 12. Veinlets of quartz with chalcopyrite in thinly banded and sheared Ord Mountain Group volcanic rocks in the Coupon Ledge, Central claim, Ord Mountain mine.

Ord Mountain mine: for example, an ore body that was wedge-shaped downward, between distinct, converging foot and hanging wall faults, was mined between I and III levels; and a body that was bounded by several distinct faults was mined on III level.

The most common primary ore minerals of the veins of the system are chalcopyrite and chalcocite; the most common secondary copper mineral is chrysocolla. No significant difference in the character of veins was dis-

Figure 13. Coupon Ledge, Central claim. Irregular banding of quartz shown in upper center grades toward the lower left corner into massive quartz with only scattered remnants of sheared andesite country rock.

cerned by the writer through the general vertical extent of the exposed part of the system, which ranges in elevation from about 3,700 to 5,900 feet. The depth of oxidation in the deposits probably ranges from 100 to 125 feet or slightly more.

The average grade of the ore bodies mined in the Rio Vista workings probably ranged from 2 to 4 percent copper and 0.2 to 0.3 ounces of gold and 0.1 to 0.5 ounces of silver per ton. Parts of the large body mined on III level of the Rio Vista workings may have contained as much as 5 or 10 percent copper. Assays for samples collected from veins of the Ord Mountain mine, as reported by Place (1917) and others, have ranged from 2 to 18 percent copper, and a trace each to one ounce of gold and 5 ounces of silver per ton.

NORTHWEST AREA OF VEINS

The northwest area of veins lies in a group of low hills which are northwest of Ord Mountain. The group consists of about 14 veins which cut hybrid rock. They range in length from slightly less than 100 feet to about 2,500 feet, and in width from about one foot to 25 feet. The pattern of distribution of the veins is crudely concentric (pl. 1), which suggests that the veins filled tension cracks.

Chalcopyrite and chrysocolla were observed in several of the veins, and galena was noted in three of them. The principal prospect in the group is the Martha, which contains galena and sphalerite. As chalcopyrite is present only in veins near the center of this system, and galena only in veins in the outer part, these minerals appear to be zonally arranged. The widest and longest vein in the system consists entirely of "bull" quartz.

NORTHEAST-CENTRAL AREA OF VEINS

This group comprises six veins, of variable strike, which dip steeply in extrusive volcanic rocks of the Ord Mountain Group. The veins range in length from about 200 to 2,000 feet. The longest one ranges in width from 50 feet on the west end to between 10 and 15 feet on the east end. The west end of this vein is composed solely of bull quartz, but the central and east parts contain copper minerals, and probably gold and silver, which have been mined. The second longest vein—about 1,500 feet in length—ranges in width from 5 to 8 feet, and is the setting for the eastern part of the Gold Banner mine.

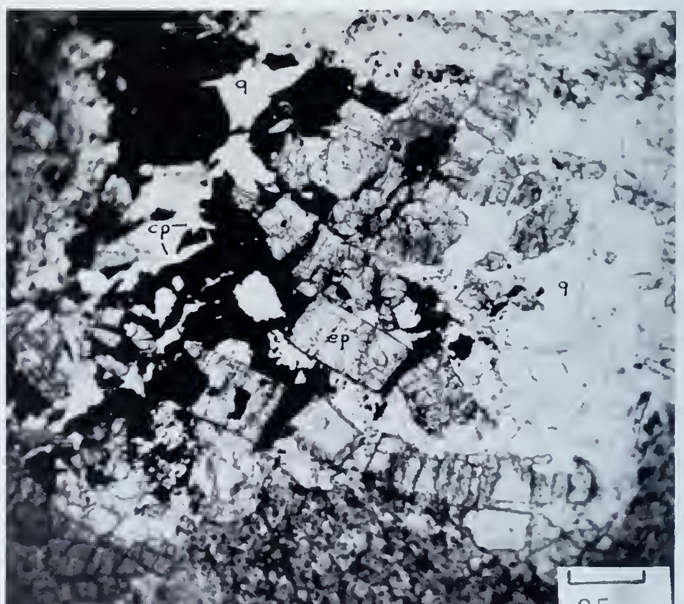
These veins are similar in mineralogy to those of the Ord Mountain system. The gangue is chiefly quartz which contains relatively abundant chrysocolla, and minor proportions of chalcopyrite.

NORTH-CENTRAL AREA OF VEINS

Four partly silicified fissure veins, which strike N. 35°-40° W., occur in the Ord Mountain Group of metavolcanic rocks, in the north-central part of the district.

Figure 14 (above). Photomicrograph of thin section in ordinary light showing opaque veinlets and single grains of chalcopyrite (cp) which have penetrated between grains of quartz (q) veinlet (light color) in sheared andesite (upper and lower parts). From Ord Mountain mine.

Figure 15 (below). Photomicrograph of thin section in ordinary light showing chalcopyrite (cp) which has penetrated between prisms of hydrothermal epidote (ep) and quartz (q) in andesite. From Ord Mountain mine.



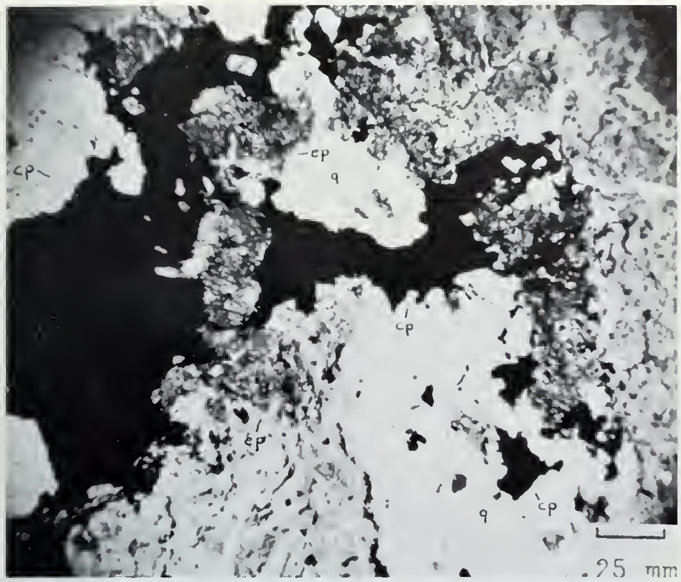


Figure 16. Photomicrograph of thin section in ordinary light showing veinlet of chalcopyrite (cp) with epidote (ep) which has cut earlier veinlet of quartz (q) in andesite. From Ord Mountain mine.

They lie nearly end to end, and are closely adjacent and nearly parallel to the contact between hybrid rock and metavolcanic rocks. They are stained with chrysocolla, and, although several prospect pits have been sunk in them, no ore has been uncovered. The veins dip about 70° southwest and range in length from 100 to 300 feet. They crop out very close to small bodies of biotite granite, to which they may be related genetically. Perhaps also related to the veins of this group are the northeast-trending vein to the south which contains the Greenback prospect, and a north-trending vein about 1,000 feet north-northeast of the Greenback prospect.

RED HILL AREA OF VEINS

The Red Hill group consists of at least 6 parallel, north-northeast trending quartz veins and mineralized rhyolite dikes. The group lies near the southern edge of the area mapped for this report, and is the setting for the Red Hill prospects. The veins dip steeply, are offset by faults, and are of variable width and length; the two longest veins are each about 1,000 feet long. The common ore minerals are chrysocolla, chalcopyrite, chalcocite, molybdenite, and powellite. At least several of the veins commonly contain abundant fragments of the metavolcanic host rock.

Mineralogy

The mineralogy of the fissure veins of the five systems is generally uniform and quite simple. Chalcopyrite, the principal sulfide mineral, is disseminated sparsely through many of the veins and is abundant at several localities. Other hypogene metallic minerals which occur locally are bornite, galena, molybdenite, sphalerite, pyrite, specular hematite, and marcasite. Scheelite noted in one deposit may be hydrothermal. Primary gangue minerals, in addition to quartz, are barite, fluorite, epidote, calcite, chalcedony, and siderite(?). Common secondary vein minerals are chalcocite, abundant chrysocolla, hematite, hydrous iron oxides (limonite), malachite, and azurite. Native silver identified in one specimen probably is of secondary origin.

HYPOGENE MINERALOGY AND PARAGENESIS

Barite (Barium Sulphate). Barite is a very abundant gangue mineral in the Josephine Ledge, in the Brilliant Ledge (where opened by the workings of the Brilliant claim of the Ord Mountain mine), and at several other localities.

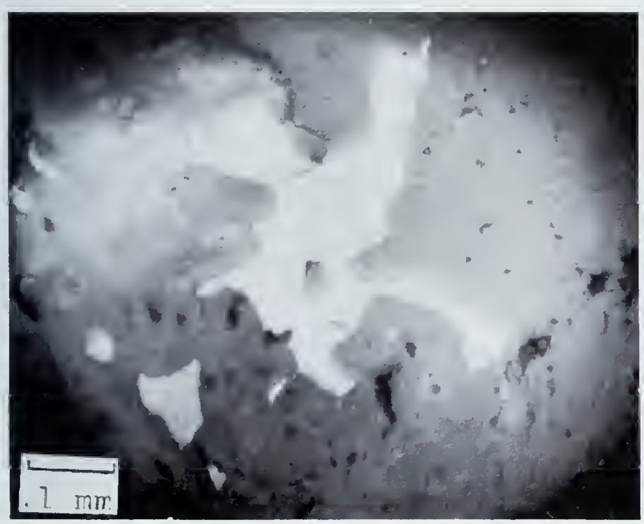
Bornite (Sulfide of Iron and Copper). Bornite was found by the writer only on the dump of the Central Tunnel of the Ord Mountain mine. There it occurs abundantly in quartz vein fragments as randomly-oriented veinlets.

Calcite (Calcium Carbonate). Pale-gray calcite occurs sparingly as a hypogene mineral in a few of the veins.

Chalcedony Variety Jasper (Silicon Dioxide). Brown and red jasper occur as thin colloform bands and as irregular masses within quartz of the northwest area system of veins.

Chalcopyrite (Sulfide of Iron and Copper). Chalcopyrite is the earliest and most abundant sulfide mineral in the vein deposits. It occurs most commonly as irregular veinlets and disseminated clusters of grains or indi-

Figure 17. Photomicrograph of polished section showing bornite (light-colored) in quartz (gray). Bornite has been partly replaced by very thin slivers of chalcopyrite (slightly lighter colored than bornite). From Ord Mountain mine.



vidual grains. The mineral also was emplaced late, as shown by guided replacement veinlets along boundaries between quartz grains (fig. 14) and along contacts between grains of epidote and quartz (fig. 15). A veinlet of chalcopyrite that cuts across a veinlet of quartz is shown in figure 16. In specimens gathered from the dump of the Central Tunnel, the writer observed chalcopyrite inclusions in bornite. These inclusions are assumed to be earlier than the bornite. In one polished section examined (fig. 17), however, chalcopyrite has replaced bornite along cleavage traces.

Epidote (*Silicate of Calcium, Iron and Aluminum*). Epidote is common as an early-crystallizing gangue mineral in the quartz veins of the Coupon Ledge.

Fluorite (*Calcium Fluoride*). Colorless and purple, massive fluorite is common as a late-forming mineral in the district, especially in the Sunset Ledge.

Galena (*Lead Sulfide*). Galena was seen by the writer only at the Martha prospect and at two other localities roughly one-half mile north and northwest of that prospect. At the Martha prospect the mineral occurs in quartz with subordinate proportions of sphalerite, marcasite, and pyrite. A polished section of a specimen from this deposit shows an irregular inclusion of a grain of pyrite within a crystal of galena, suggesting that the galena may have crystallized around, or may have partly replaced a larger mass of pyrite, and thus be later (fig. 18).

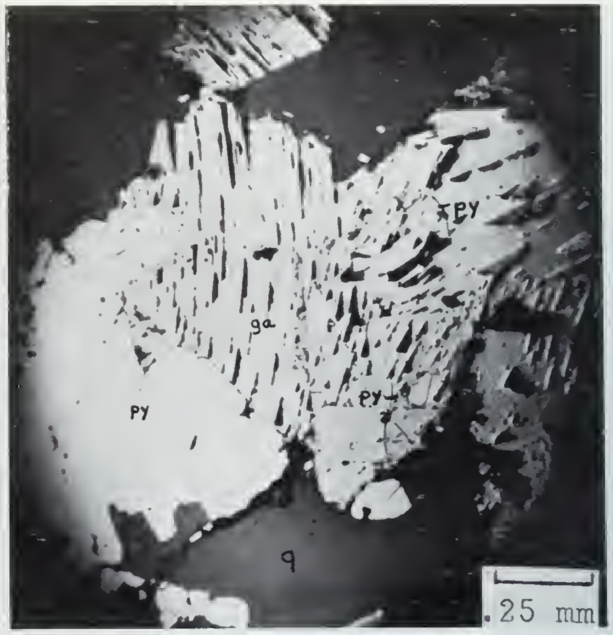


Figure 18. Photomicrograph of polished section showing galena (ga) and pyrite (py) in quartz (q). From Martha prospect.

Gold. Gold occurs principally in the fissure veins of the Ord Mountain fault zone system, but was not seen by the writer in specimens collected.

Hematite (Iron Oxide). Metallic blades of specular hematite occur with penninite as an early-forming mineral on walls of quartz veins at several localities (fig. 19).

Marcasite (Iron Sulfide). Cockscomb marcasite occurs very sparingly with galena and sphalerite in vugs in quartz at the Martha prospect.

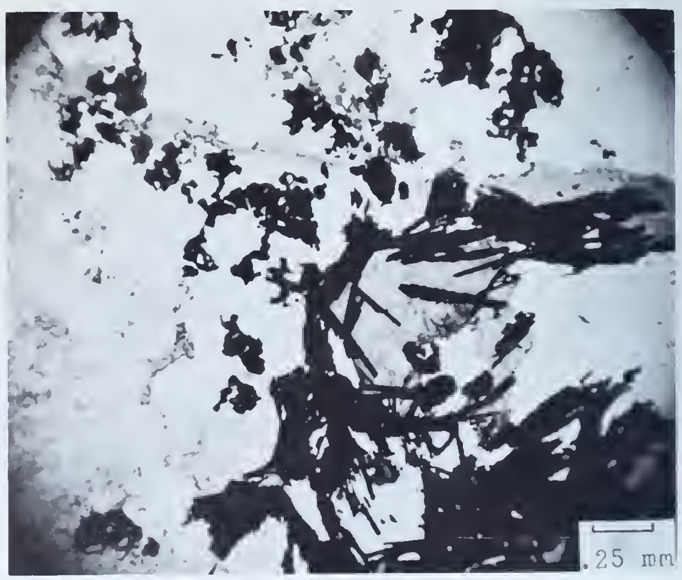
Molybdenite (Molybdenum Sulfide). Molybdenite occurs with chalcopyrite as an important constituent of quartz veins of the Red Hill area, in the south part of the district. It also occurs in the south part of the district in mineralized rhyolite dikes.

Pyrite (Iron Sulfide). Pyrite is uncommon in the district; it occurs sparingly at the Martha prospect, and is uncommon to rare in the veins of the Ord Mountain system.

Quartz (Silicon Dioxide). Milky quartz is the principal hydrothermal mineral in nearly all the fissure veins of the district. Although the earliest mineral to have crystallized, it may have been deposited throughout the sequence of mineralization, and therefore also may be very late. Quartz crystals at the Martha prospect are the largest noted in the district, with prism faces as long as one inch.

Scheelite (Calcium Tungstate). Small grains of scheelite are disseminated in quartz at the Greenback deposit. They are believed to be of hydrothermal origin.

Figure 19. Photomicrograph of thin section in ordinary light showing blades and irregular masses of hematite variety specularite (opaque) with chlorite (dark gray) on wall of vein of quartz (very light colored) which is bordered by hybrid rock (light gray; left edge). Locality near Martha prospect.



Sphalerite (Zinc Sulfide). Sphalerite occurs very sparingly with quartz at the Martha prospect, where it forms dark brownish-red crystals as long as 5 mm.

Siderite (?) (Iron Carbonate). Veinlets of a nearly opaque, brown, carbonate-like mineral, which may be siderite, were noted in several thin sections.

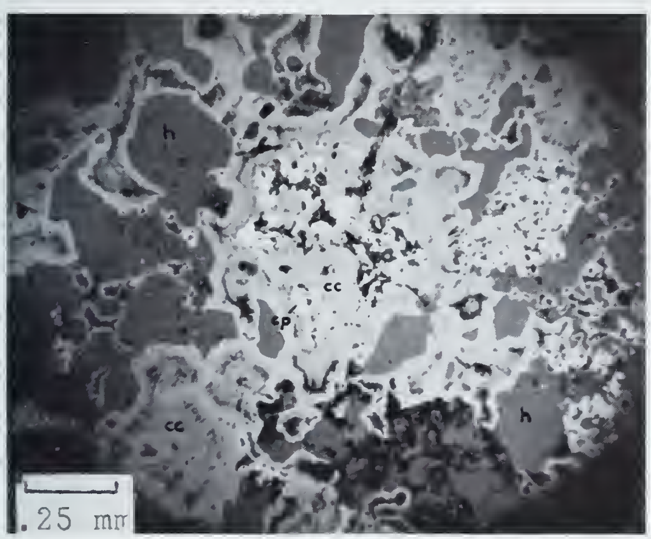
OXIDATION, AND SUPERGENE MINERALOGY

The scarcity of pyrite, from which $Fe\,SO_4$, $Fe_2\,(SO_4)_3$, $FeCl_3$, and other solvents could have been produced by supergene oxidation and leaching, apparently has inhibited intensive attack on the chalcopyrite, and therefore has prevented the formation of a zone enriched in secondary minerals beneath the water table. Only a minor proportion of chalcopyrite generally has been oxidized in place. Oxidation of veins of the Ord Mountain fault zone system is estimated to range in depth from about 100 to 125 feet or slightly more.

Azurite (Hydrous Copper Carbonate). Brilliant blue crystals of azurite as long as one-eighth inch occur as druses in vugs and cracks in keratophyre of the Ord Mountain Group at the Brilliant claim of the Ord Mountain mine.

Calcite (Calcium Carbonate). Coarse-grained, impure, white calcite has been deposited near the surface and along the footwall of the north part of the Coupon Ledge. Where examined the deposit is about 15 feet thick.

Figure 20. Photomicrograph of polished section showing chalcopyrite (cp), with inclusions of covellite (?) (thin, dark-gray slivers), which has been replaced partly by wavelike masses of chalcocite (cc) and hematite (h). From Ord Mountain mine.



Chalcocite (Copper Sulfide). An example of partly altered chalcopyrite is shown in figure 20. The primary chalcopyrite contains wedge-shaped inclusions of covellite(?) and is randomly traversed by undulating veinlets of chalcocite which is bordered by hematite.

Chrysocolla (Hydrous Copper Silicate). Hydrous copper silicate, apparently chrysocolla, is the most abundant and most common copper mineral in the district. It forms crusts, scales, and seams in all occurrences of copper mineralization noted by the writer.

Copper. Native copper was reported by Place (1917) to occur as worms and granules above the water level in the Rio Vista workings of the Ord Mountain mine. The mineral was not observed by the present writer.

Covellite(?) (Copper Sulfide). Blue, wedge-shaped inclusions in chalcopyrite, as seen in polished section, are believed to be covellite.

Cuprite (Copper Oxide). Veinlets of metallic-gray cuprite in fluorite were seen at one locality in the Sunset Ledge, just northeast of the Mineral Ridge fault. At this locality the mineral is partly altered to malachite.

Hematite (Iron Oxide). Hematite is common, with hydrous iron oxide minerals, adjacent to altered chalcopyrite. It is abundant in altered zones in the south part of the district.

Jarosite(?) (Hydrous Sulfate of Iron and Potassium). Coatings of drusy, yellow-brown vitreous crystals on quartz in the Martha and Greenback deposits may be jarosite.

Limonite (Hydrous Iron Oxides). The vari-hued yellow and brown hydrous iron oxide minerals formed in the district as a result of the alteration of hypogene sulfide minerals that contain iron can be grouped under the general term "limonite". One such mineral found that is commonly dark, oily brown in color probably is goethite.

Malachite (Hydrous Copper Carbonate). Tufts of acicular malachite crystals with chrysocolla and azurite are uncommon but not rare in the district.

Powellite (Calcium molybdate). Powellite occurs with molybdenite, as an alteration product of that mineral, in veins of the Red Hill area.

Pyrolusite(?) (or psilomelane). Manganese oxide, probably pyrolusite or psilomelane (with barium), occurs sparingly with iron oxide minerals in hydrothermally altered rocks in the extreme south part of the district.

Silver. Native silver was noted in one specimen of vein material found on the dump of the Central Tunnel of the Ord Mountain mine. It occurs as thin, twisted sheets, not more than 2 mm. in length, with chalcopyrite, bornite, and quartz.

Valentinite(?) (or cervantite; antimony oxide). One of these minerals occurs sparsely as yellow coatings at the Martha prospect. The primary mineral from which it altered was not seen.

Rock Alteration

General Features. Rock alteration caused by deuteric, contact metasomatic, and hydrothermal processes is widespread in the Ord Mountain district. The probable distribution in silicic and basic rocks of minerals produced by these three processes, as compiled from rather meager data, is shown in table 3. Notable features disclosed by the table are (1) that chlorite is a common alteration mineral of all three processes in both silicic and basic rocks, (2) that quartz, albite, and sericite are common products of all three processes in silicic rocks, and (3) that there is a general lack of epidote in hydrothermally and deuterically altered silicic rocks.

Table 3. Genetic distribution of alteration minerals in silicic and basic rocks.

	Deuteric		Contact metasomatic		Hydrothermal	
	Silicic Rocks	Basic Rocks	Silicic Rocks	Basic Rocks	Silicic Rocks	Basic Rocks
Quartz	c	u	c	c	c	c
Albite	c	c	c	?	c	c
Chlorite	c	c	c	c	c	c
Sericite	c	u	c	c	c	u
Epidote	–	c	c	c	–	c
Carbonate minerals	–	–	c	?	u	c
Argillite	–	–	–	–	u	u

Explanation of symbols: c, common; u, uncommon; –, generally not present; ?, uncertain.

During the alteration processes only silica and perhaps minor proportions of carbon dioxide and iron need have been introduced in order to have caused the observed partial reconstitution. All the necessary sodium, calcium, potassium, magnesium, aluminum, and perhaps even carbon dioxide and iron, of the secondary minerals, could have been derived from the minerals which comprised the invaded rocks.

Rock Alteration as a Guide to Ore. Regional deuteric alteration and local hydrothermal alteration in the Ord Mountain district cannot be easily distinguished everywhere, and thus zones or halos of alteration which are adjacent to veins are difficult to recognize. No one alteration mineral or group of minerals seems to be indicative of the proximity of metallic mineralization. The best guide is intensity of alteration. For example, silicification is regional and its presence is not indicative of a vein nearby, but intense silicification is common only adjacent to mineralized zones. This is shown at a locality about 50 feet north of the shaft of the Martha prospect, where a zone of intense argillization and silicification about 20 feet wide suggests the presence of a quartz vein beneath the surface of the ground (fig. 21).

The abundance of epidote in basic rocks is deceptive; in hybrid rock adjacent to veins the characteristic pistachio green of epidote is outstanding. However, the mineral also is extremely common in contact zones and, as a guide to hydrothermal mineralization, it would have to be used with great discretion, if at all.

Age Relations

The absolute age of the fissure veins of the district can only be surmised, because the host rocks themselves are dated only questionably. Although the five systems of veins are completely separated, they are believed to be contemporaneous, or nearly contemporaneous, as they are relatively similar in mineralogy and texture, and only one example was noted of a vein cutting another vein. This example consists of a thin, insignificant east-trending vein which cuts the Last Chance Ledge, and apparently is slightly younger.

The youngest rock bodies cut by the veins are a basalt dike of Cretaceous or Tertiary(?) age one mile west-southwest of the Martha deposit, and a rhyolite dike of the same age on Mineral Ridge. In addition, several of the rhyolite dikes are hydrothermally mineralized. Veins have been emplaced closely adjacent to, but do not cut, porphyritic biotite dacite near the Martha deposit and at a locality one-half mile east of Ord Mountain summit. Veins do not cut rhyolite-dacite breccia which, from its lack of weathering and only slightly tilted attitude, is thought to be relatively recent. From the evidence above it is believed that the quartz veins are no older than Cretaceous and perhaps as young as middle or late Tertiary.

Genesis and Classification

The hydrothermal solutions that were deposited to form the fissure veins of the district were emplaced mainly in joints and faults, and subordinately in irregular zones of crushed rock and in slightly fractured rhyolite dikes. The solutions probably ascended in tightly confined, but partly open systems, and minerals were precipitated as the temperatures and pressures of the solutions decreased upward from their source and closer to the surface of the earth. The vein minerals were deposited (1) as individual veins in single joints and shear fractures, (2) as composite masses of closely spaced veinlets in weak shear fractures separated by sheared or broken, altered host rock, and (3) as nearly solid bodies as thick as 25 feet, where sheared wall rock between veins and veinlets was permeated and replaced by vein minerals (pl. 2, fig. 13).

The probable means of localization of two of the larger ore bodies mined in the Coupon Ledge (Rio Vista workings, Ord Mountain mine) are illustrated as follows: (1) The downward-wedge shaped body mined between I and III levels probably formed in the part of a channel carrying ascending hydrothermal solutions which widened upward relatively abruptly (pl. 2). As the ascending solutions entered the wider area of the channel, their confining pressure decreased (and, consequently, also their temperature), thus creating conditions for precipitation of ore minerals. (2) One of the richest ore bodies mined, on level III, was bounded by several faults; and it is surmised by the writer that these faults formed a structural trap which somehow impeded the ascending solutions, thus allowing ore minerals to precipitate.

The greatest contrast in character of the veins of the district seems to be between veins of the Ord Mountain system and those of the northwest group. These contrasting characteristics are illustrated by the following criteria:

(1) Ord Mountain System of Veins
- (a) Epidote and albite as vein minerals.
- (b) Massive milky quartz—voids nil.
- (c) Crude banding in fissure veins.
- (d) Relative abundance of quartz, sericite, and epidote as wall rock alteration minerals.

(2) Northwest System of Veins
- (a) Colloform jasper in one of the veins suggests colloidal deposition.
- (b) Coarse-grained crystalline and vuggy texture of quartz with euhedral crystals of galena, marcasite, and pyrite from the Martha prospect.
- (c) Argillization of wall rocks of the Martha deposit.

The criteria indicate that veins of the Ord Mountain Group probably were deposited at higher temperatures and pressures than those of the northwest group. All vein deposits of the district, however, seem to fit Lindgren's (1928, p. 238) classification as mesothermal.

Description of the Mines

GOLD BANNER MINE

The Gold Banner mine is in the SE¼SE¼ sec. 12, T. 7 N., R. 1 E., and the SW¼SW¼ sec. 7, T. 7 N., R. 2 E., S.B.M., at the south end of Aztec Valley. Nine unpatented claims were held in 1956 by the estate of W. M. (Doc) Smith, formerly of Daggett, California. The property probably was developed mainly during World War I when several hundred tons of gold ore was mined and shipped. Only a minimum of work has been done since that time. In 1957, E. P. Davis of Daggett shipped a small tonnage of gold-silver-copper ore from the mine.

The Gold Banner mine comprises two separate deposits. One is about 800 feet west of the Aztec Valley ranch house, and the other is about 1,000 feet east of the house. The deposit west of the ranch consists of an altered pale-gray volcanic dike which strikes N. 35° W. in extrusive andesite of the Ord Mountain Group. At the surface the dike is about 4 feet wide. A shaft is inclined 65° west on the dike; in December 1955, the shaft was inaccessible but was estimated to be 100 feet deep by the writer and to contain an undetermined amount of underground workings. Values are assumed to be mainly in gold and/or silver as no copper minerals were seen in the dump.

The deposit east of the ranch consists of a fissure vein about 5 feet wide which strikes N. 40° E. and dips 75° southeast in extrusive andesite of the Ord Mountain Group. Values are apparently in copper and gold. The deposit is developed by a drift adit and appended level workings which total about 250 feet.

GREENBACK PROSPECT

The Greenback prospect is nearly 0.7 miles north-northwest of the Aztec Valley ranch house, in the E½-NE¼ sec. 12, T. 7 N., R. 1 E., S.B.M. It is owned by B. H. Nunnalee and R. M. Wilhoite, 1546 W. 7th St., Los Angeles (1959).

The deposit was opened in 1898, and has been prospected sporadically since that time. In 1939, a small acid leaching plant was constructed on the property, but the venture was unsuccessful. In 1957, the property was purchased by the present owners who by 1959 had deepened the more southwesterly of two shafts. No production has been reported from the property.

Copper minerals occur in a vertical vein which is about 5 feet wide and strikes N. 30° E. in metamorphosed extrusive rocks of the Ord Mountain Group. The exact length of the vein was undetermined, but is more than 300 feet. The mineralogy is characterized by an abundance of hematite, hydrous iron oxides, and chrysocolla. Jarosite(?) was observed in fractures in the wall and vein rock. Minute specks of scheelite in quartz were observed by ultra violet light in specimens collected from the dump. The two shafts are about 35 feet apart and each is about 50 feet deep.

MARTHA PROSPECT

The Martha prospect is near the middle of the south edge of sec. 11, T. 7 N., R. 1 E., S.B.M., and on the south

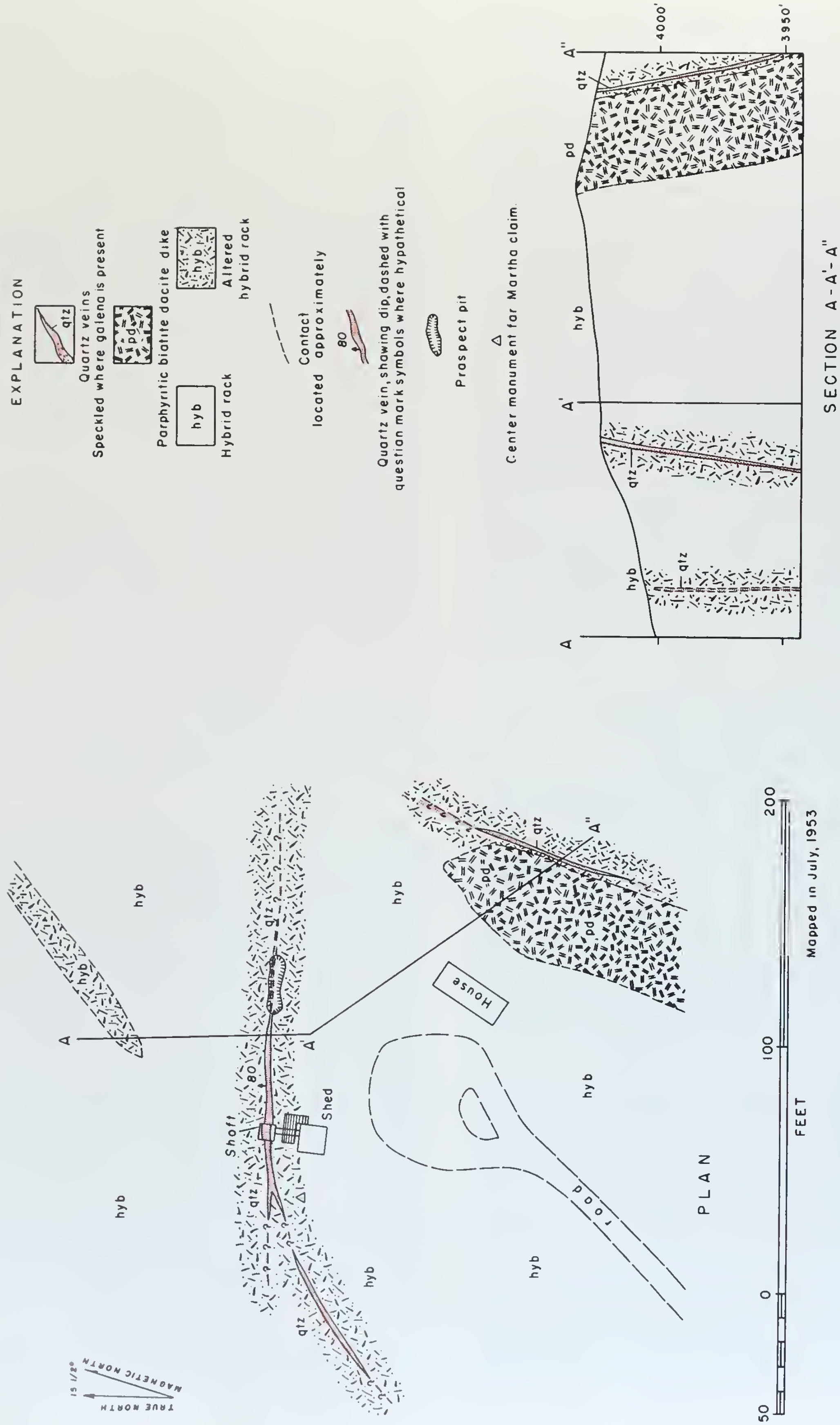


Figure 21. Geologic map and cross section of the Martha prospect.

edge of a group of low hills which lie northwest of Ord Mountain. L. C. Coltrane of Baldwin Park holds one unpatented claim, the Martha No. 1 (1953). A headframe, living quarters, and a tool shed were constructed on the property in early 1953. These had been removed or destroyed by 1959.

The deposit was opened in 1953 and prospected briefly. It consists of an east-trending quartz vein which dips very steeply to the north in hybrid rock and branches to the southwest (fig. 21). The total length of the vein, including its branch, is about 300 feet. It ranges in width from 0 to about 4 feet. The principal ore mineral is galena with subordinate proportions of sphalerite. The presence of a primary antimony mineral is suggested by thin coatings of sparse valentinite(?) (or cervantite(?)). The gangue is fine- to coarse-grained milky quartz, pyrite, marcasite, and an unidentified clay mineral. A little jarosite(?) has developed as druses in the fractures of the quartz. According to the owner, a sample from the vein assayed 9 percent lead and 33 ounces of silver to the ton.

The deposit is developed by a shaft, which is about 18 feet deep, and a narrow trench about 20 feet long. The possibilities for this prospect seem limited, as the vein pinches abruptly on both sides of the shaft and its character at depth is undetermined.

MARY ETTA PROSPECT

The Mary Etta prospect is in the south part of the district, high on the west side of the north-trending backbone of Ord Mountain; it lies along the north edge of the NW¼ sec. 6, T. 6 N., R. 2 E., S.B.M.

The prospect develops a thin, north-trending zone of mineralization in metavolcanic rocks of the Ord Mountain Group. It is said to have been opened, probably mainly for gold, sometime during the period 1907 to 1915.

MOLY PROSPECT

The Moly prospect is high on the southwest side of Ord Mountain, mostly in the W½SW¼ sec. 30, T. 7 N., R. 2 E., S.B.M. The principal working, which is near the center of the W½SW¼ sec. 30, can be reached from the Red Hill prospects via a steep, winding road. The area has been prospected for many years, but the principal exploration work was being done during the late 1950's by J. A. Thiede, 5269 Batavia Road, South Gate, and F. H. Holmes, Highland Park. The property holdings of Mr. Thiede consist of an undetermined number of unpatented claims (1961).

The Moly prospect is at the south end of the Ord Mountain fissure vein system which to the north contains the Ord Mountain mine. The Moly deposit consists of copper- and gold-bearing bodies in sheared and fractured metavolcanic rocks of the Ord Mountain Group, which have been hydrothermally altered and mineralized, then faulted again. These rocks cover an irregular area mainly in the W½ sec. 30. The foliation and shears of these rocks generally strike north and dip steeply, mainly to the east. Assays of three grab samples taken by the writer from the surface of altered rocks in sec. 30 (pl. 1) ranged in grade from a trace to 0.05 percent copper. Analyses were not made for other elements.

During parts of 1958 and 1959, Mr. Thiede was driving a drift adit, with short appended workings, northward along a silicified zone of variable width which contains chalcopyrite, chrysocolla, pyrite, and copper oxide minerals. The working was about 150 feet long by October 1959.

ORD MOUNTAIN MINE

(Ord Copper Group—Ord Mines, Inc., Osborn Group)

The Ord Mountain copper-gold mine is the most productive property of the district. The mine comprises a north-trending series of adits, shafts, and prospect pits on the northwest side of Ord Mountain, in the central part of the district. Eight patented claims and about 20 unpatented claims mainly in sections 12, 13, and 24, T. 7 N., R. 1 E., S.B.M. are owned by H. J. Stevenson, 328 Mason Rd., Vista (1962) (fig. 22).

Although developed during a period of more than 80 years, the total output from the mine is reported to be less than 2,000 tons of ore. The mine has been idle since 1942 except during a brief exploration program conducted in 1956 by the Nipissing Mining Company of Canada. The only useable installations on the property in 1955 were a combination bunk and cookhouse in Sweetwater Canyon, an ore chute on the dump of the Josephine claim adit in Sweetwater Canyon, and a shack near the portal of the III Level adit of the Rio Vista workings of the Rio Vista claim. The reported production is shown in table 1.

The mining development, and the geology and mineralogy of the mine are discussed below by groups of claims which include: (1) Brilliant claim, (2) Copper Junction-Belgium-Tehachapi claims, (3) Coupon claim, (4) Josephine claim, (5) Last Chance claim, (6) Modesto claim and (7) Rio Vista-Central-England claims.

(1) *Brilliant Claim.* The Brilliant claim covers the extreme north end of the Brilliant Ledge of the Ord Mountain fault zone, and thus encompasses the extreme north part of the mine. The Ledge is in sheared and chloritized keratophyre of the Ord Mountain Group. At the surface it dips 70°-75° west. The principal gangue minerals are quartz and barite. Azurite and malachite are common in surface exposures of the Ledge and chrysocolla is very common in parts of the Ledge exposed underground. Chalcopyrite is said to be dissem-

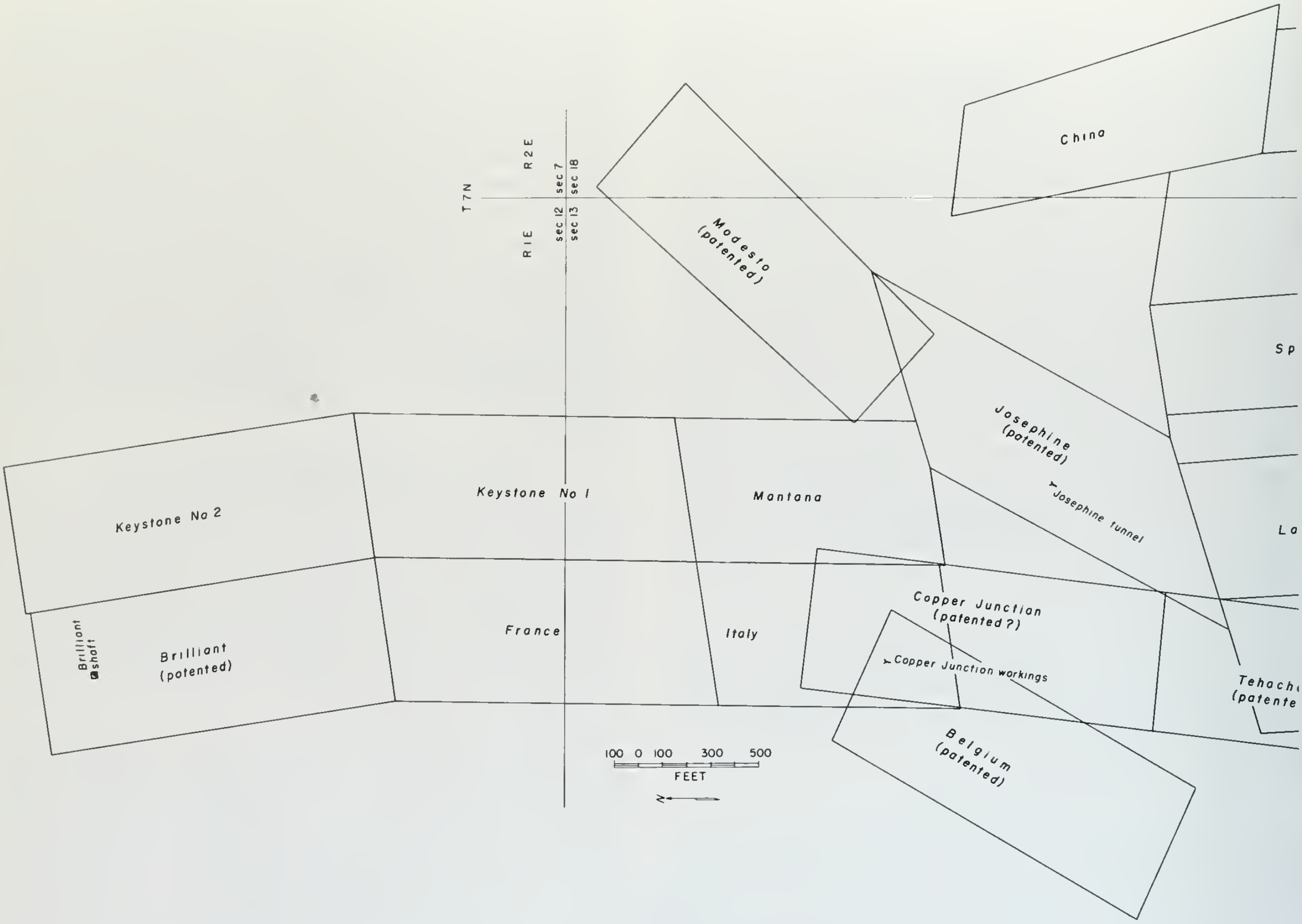
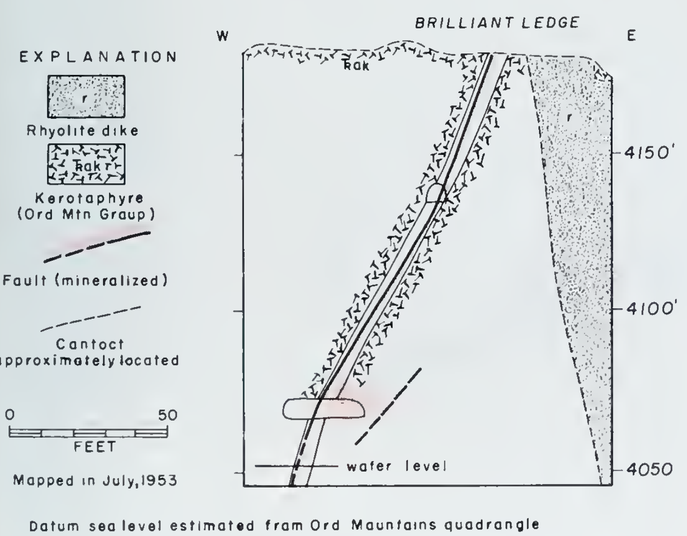


Figure 22. Principal claims of the Ord Mountain mine.

Figure 23A. View north shows extreme north part of the Brilliant Ledge in which Brilliant shaft (shown) is sunk. At this locality the part of the Ledge exposed at the surface contains hydrous oxide and carbonate minerals of copper. At a point several hundred feet beyond shaft, the Ledge is cut off by the Aztec Valley fault. Hills in background are composed of hybrid rock.

Figure 23B. Geologic cross section through the Brilliant shaft, Ord Mountain mine.



inated sparsely through the gangue in the now inaccessible lowest level of the workings.

Within the claim the Brilliant Ledge is developed chiefly by the Brilliant shaft and a series of shallow cuts (figs. 23a and 23b). The Brilliant shaft is inclined about 70° on the Ledge at the surface and has a total depth of 182 feet (Tucker and Sampson, 1930). In 1953 and 1955, the shaft was filled with water below a depth of 142 feet, and 100 feet of level workings reported to be below that level were inaccessible. Level workings above the water line, and accessible from the shaft by ladder in 1955, consist of a short drift near the surface and a drift about 50 feet long driven south from a point 128 feet below the collar of the shaft. The last mining on this property was in 1942, when about 80 tons of ore was mined from the Brilliant shaft by the Symons Brothers Company of Los Angeles, for H. J. Stevenson.

Faces of the drifts that now are under water were reported by Tucker and Sampson (1930, p. 218) to aver-

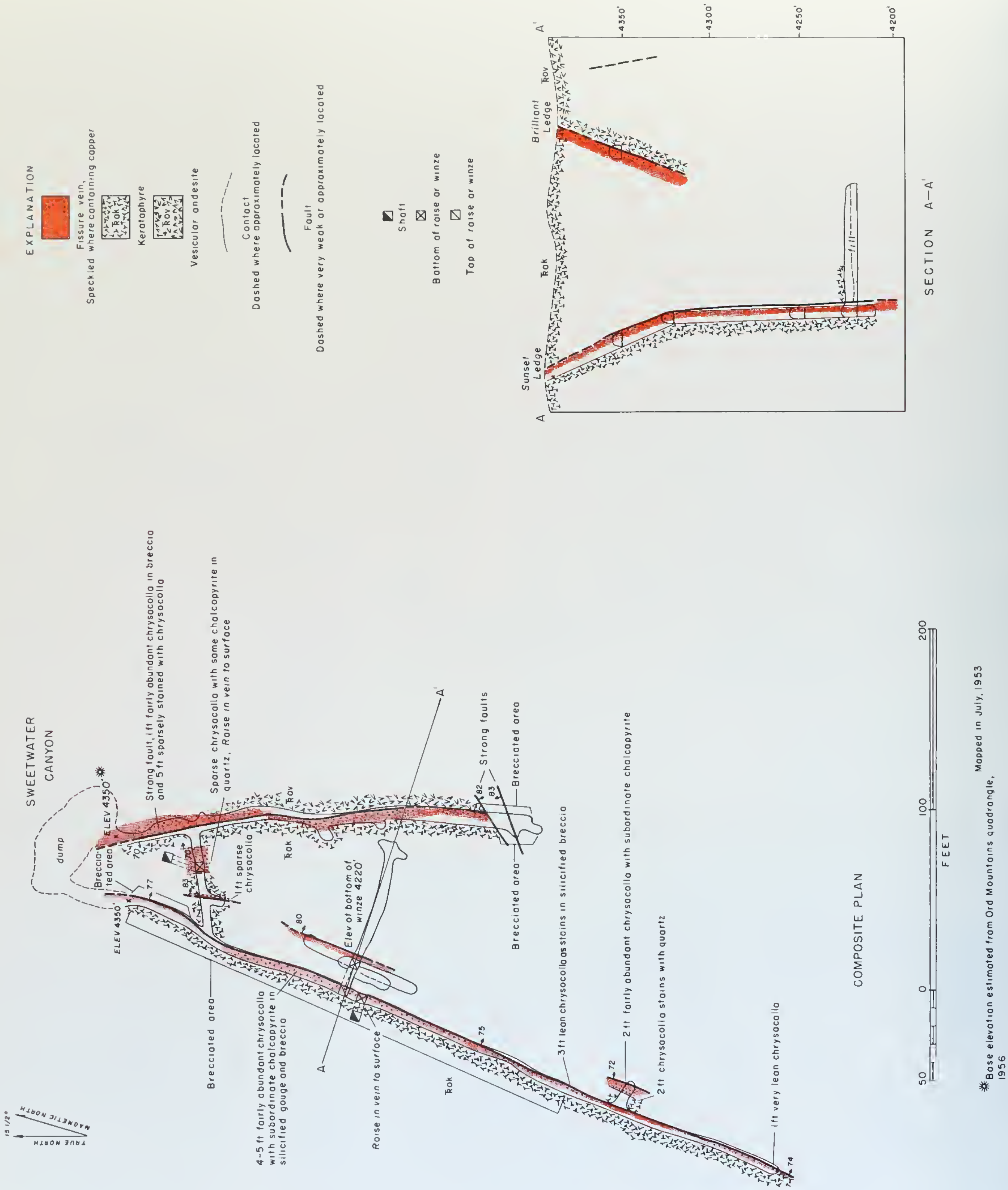


Figure 24. Geologic plan and cross section of the Copper Junction claim workings, Ord Mountain mine.

age 3 percent copper and $4 in gold per ton. One shoot of rich ore in the drowned workings was reported by Place (1917) to average 18 percent copper. Above the water level, the ore is lower in grade, although the vein is nearly 10 feet wide on the 128-foot level. The following result for a sample collected on this level was given by Place: copper, 1.90 percent; gold, 0.045 ounces per ton; and silver 4.40 ounces per ton.

(2) *Copper Junction - Belgium - Tehachapi Claims.* These claims lie slightly more than one-half mile south of the Brilliant claim, and include deposits which are mainly south of the intersection of the Brilliant Ledge and Sweetwater Canyon, at the north end of Mineral Ridge (pl. 1). Most of the development work on the claims was done before 1890. Newer work has consisted only in lengthening older workings.

The principal workings of this group of claims develop the Brilliant and Sunset Ledges, which probably join beneath the alluvium in Sweetwater Canyon, just north of the portals of the drift adits driven southward on the two Ledges (fig. 24). The more easterly drift adit was driven due south on the Brilliant Ledge and was intended originally to be a haulage adit for the entire south part of the mine. It was extended 70 feet in 1925, but the vein was lost 25 feet north of the present face of the drift, where the working cut two relatively strong east-northeast striking faults. A former manager for a development operation on the property has reported that a sample taken over a width of 5 feet on this Ledge, at a point between 40 and 50 feet south of the portal of the drift adit, assayed 2 percent copper and $4 per ton in gold and silver. The grade and width of the vein in this drift seemed to the writer to be fairly uniform.

The more westerly drift adit was driven 392 feet south-southwestward on the Sunset Ledge. About 130 feet from the portal of this adit, a winze was sunk on the Ledge to a depth of 140 feet. Level workings driven from the winze total about 100 feet. The dip of the Ledge increases downward through the total depth of the winze, increasing from 75° southeast at the top to 85° southeast at the bottom. The vein maintains a uniform width of about 5 feet in the winze. At a point in the drift adit a few feet south-southwest of the collar of the winze, a raise was driven in the Ledge 40 feet to the surface. As exposed in the westerly drift, the vein decreases in thickness and in grade of copper from north-northeast to south-southwest. For example, at a point 35 feet northeast of the collar of the winze, the vein is 6 feet wide and contains a relatively high proportion of copper oxide minerals; but at the south-southwesterly face of the drift, the vein is only one foot wide and contains only very sparsely distributed stains of copper oxide minerals. At a point 95 feet from the south-southwest face, however, a crosscut driven southeastward intersected a parallel vein which is 4 feet wide and which contains a relatively high proportion of copper oxide minerals. At the surface, this vein is nearly 10 feet wide at a point several hundred feet south-southwest of the crosscut in the drift adit. The only reference found by the writer to the grade of the vein opened by the westerly drift was by Place (1917), who reported that the drift was said to have a "show of good gold ore, low in copper."

Two zones of sparse copper mineralization about 15 feet apart were cut in the 50-foot crosscut that connects the drift adits on the Sunset and Brilliant Ledges. The more westerly zone is one foot wide, and the more easterly one is about 15 feet wide. A raise was driven 40 feet to the surface on the latter vein.

The Tehachapi claim, which abuts the south end of the Copper Junction claim and extends southward to the Mineral Ridge fault (pl. 1), encloses the south part of the Brilliant Ledge. This claim is developed by several prospect pits and a shaft sunk on the Brilliant Ledge to a depth of 60 feet. According to Place (1917) "the vein looked good but assayed low in copper."

(3) *Coupon Claim.* The Coupon claim is on the northernmost part of the Coupon Ledge, which, within the claim, strikes nearly north and is bounded on the north by the Mineral Ridge fault. The Ledge dips 60° east and where observed ranges in width from 15 to 25 feet. Ore minerals in the vein are sparsely distributed chalcopyrite, chalcocite, chrysocolla, and malachite. The gangue is principally quartz, with subordinate calcite, and barite. Assay results from samples collected in the workings of the Coupon claim are shown in table 4. These results indicate that the grade and thickness of the Ledge decrease with depth.

Table 4. Results of three assays from Coupon Ledge, Coupon claim, Ord Mountain mine.

Area sampled, and authority	Thickness of vein (in feet)	Assay result
Two open cuts on surface. (Assay report of 1890)	15-25	Cu—10.0% Au—0.15 oz Ag—1.3 oz
Upper crosscut. (Place, 1917)	17	Cu—3.5% Au—0.07 oz
"Four seams of ore" in lower crosscut. (Place, 1917)	¼-2	"Averaged less than 1% copper."

The claim is developed by two crosscut adits and several open cuts and shafts (fig. 25). The upper crosscut

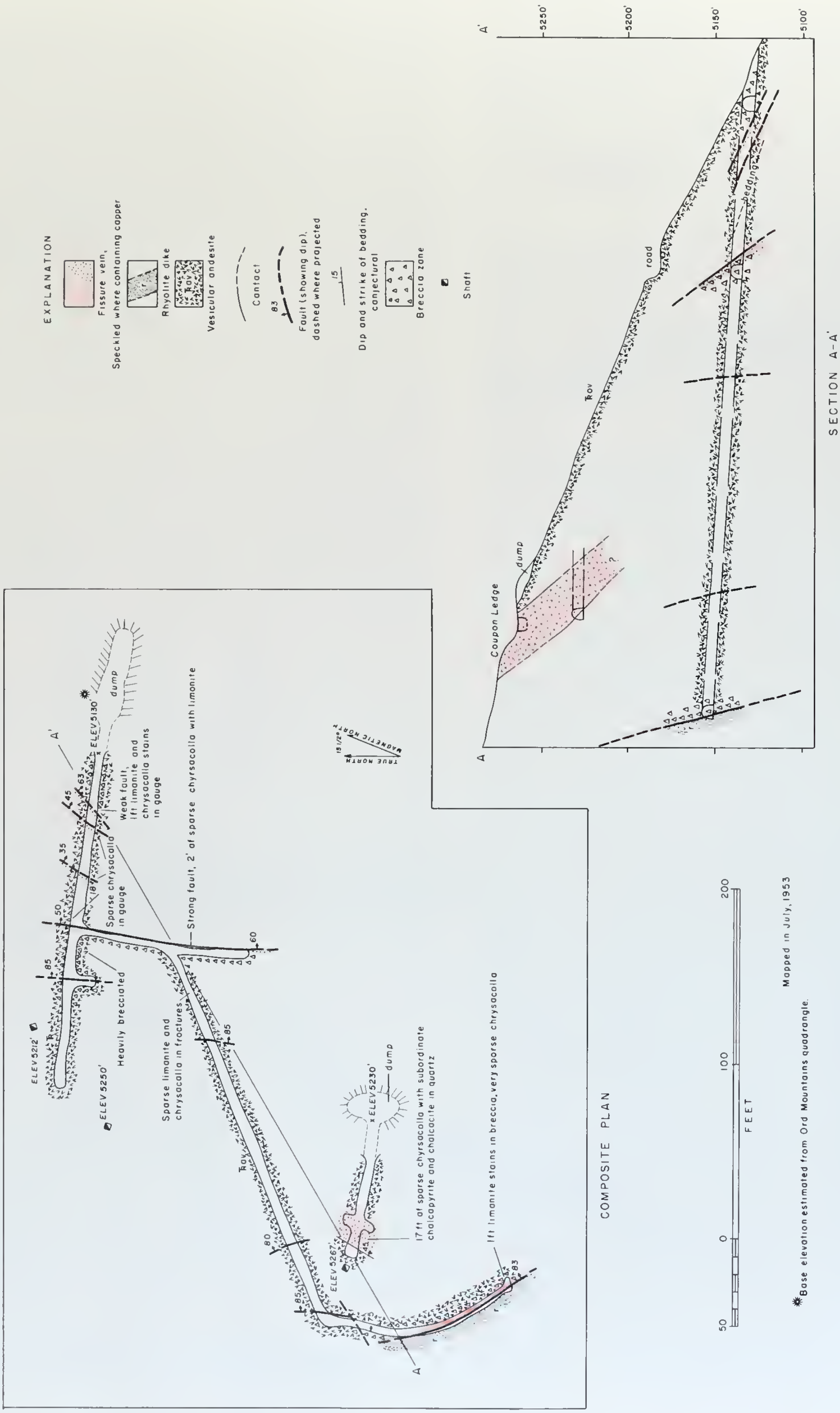


Figure 25. Geologic plan of longitudinal projection through the Coupon Claim workings, Ord Mountain mine.

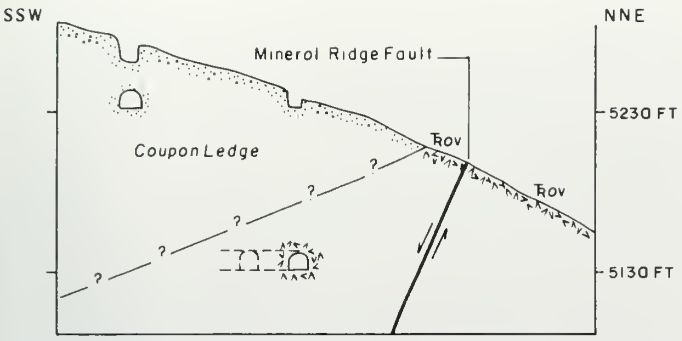


Figure 26. Hypotheticol ond ideolized longitudinol section olong Coupon Ledge ot its terminotion south of the Minerol Ridge foult. Trov (metovolconic rocks).

adit extends westward from a point about 5,230 feet in elevation on the east side of Mineral Ridge. This working is 70 feet long and cuts the Coupon Ledge at a point where it is 17 feet wide. A second crosscut adit extends westward into the ridge from a point about 100 feet lower, and northeast of the upper adit. Because this working did not intersect the Coupon Ledge, the Ledge must pinch out above the lower crosscut adit or be faulted. As the Ledge appears to pinch laterally on the surface, it may logically pinch out downward to the south (fig. 26). As no fault that could account for a dislocation of the Ledge between the upper and lower workings was evident in the workings, the pinching hypothesis seems more likely.

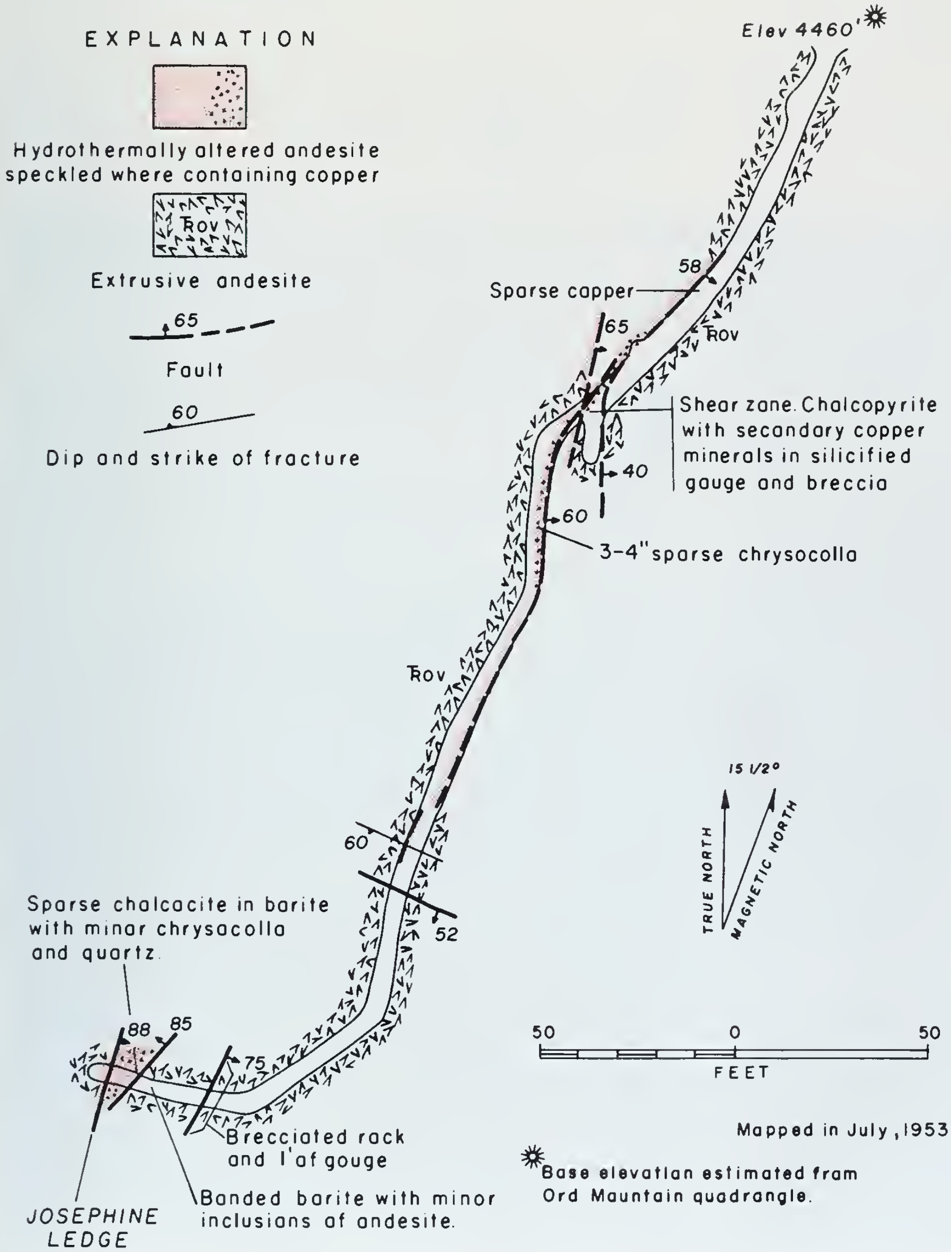


Figure 27. Geologic plon of the Josephine cloim tunnel, Ord Mountoin mine.

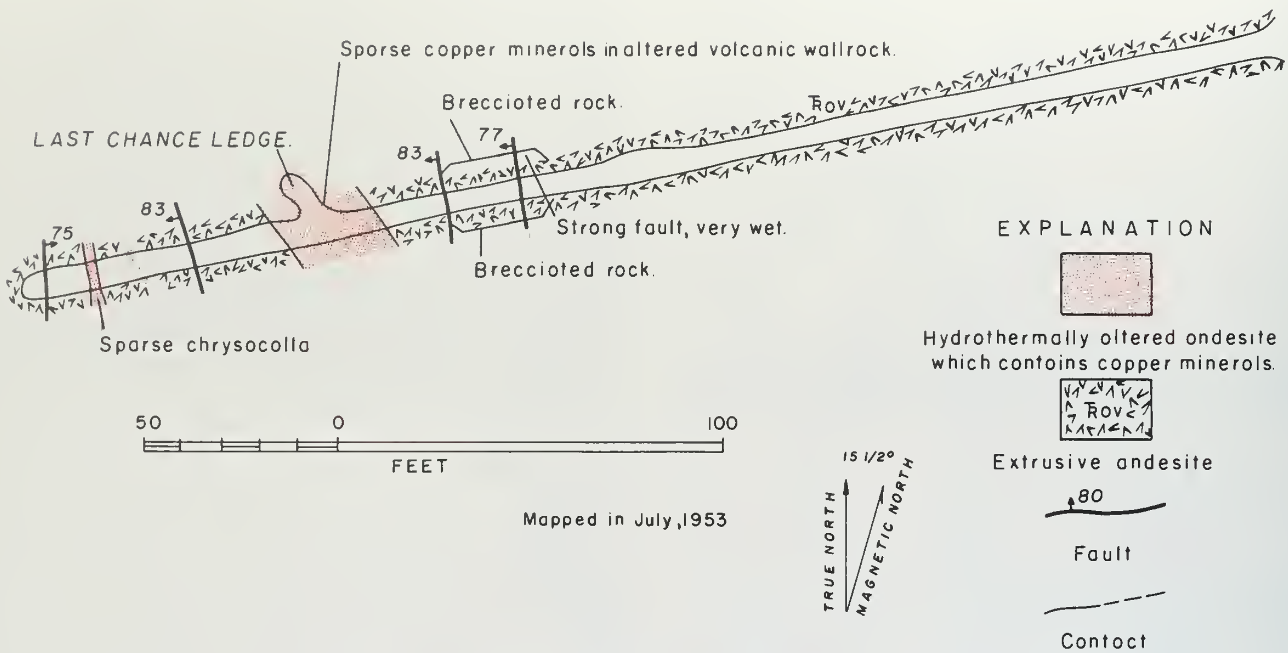


Figure 28. Geologic plan of the Last Chance cloim tunnel, Ord Mountain mine.

(4) *Josephine Claim.* The Josephine claim covers the Josephine Ledge, which extends south-southwestward for about 700 feet along the east flank of Mineral Ridge from a point on the west side of Sweetwater Canyon near the main camp of the Ord Mountain mine (pl. 1). The Ledge dips 80° to 85° west. The principal working on the claim is an adit ("Josephine Tunnel") which extends south-southwestward, nearly parallel with, and 50 feet south of the trace of the Josephine Ledge, from a point very low on Mineral Ridge. The adit was driven irregularly for 325 feet at an undetermined date before 1890 on a series of narrow veins (fig. 27). A sample from one of these veins assayed a trace of gold and silver and 2.3 percent copper. In 1925, the adit was extended to the west for 40 feet and cut the Josephine Ledge, which at that point is about 25 feet wide. A zone of copper-bearing minerals within the Ledge is about 7 feet wide, and apparently lies between two nearly vertical faults. The zone contains chrysocolla, yellow-brown iron oxide minerals, sparse chalcopyrite, and a gangue composed chiefly of barite, with subordinate proportions of quartz and an unidentified carbonate mineral.

At the south-southwest end of the exposed part of the Josephine Ledge, at a point about 500 feet southwest of the portal of the adit described above, a 78-foot vertical shaft was sunk. This shaft follows a stringer of quartz 13 inches wide which contains a relatively high proportion of chalcopyrite and copper oxide minerals. At the collar of the shaft the Ledge is about 5 feet wide, and a sample taken over this width by Place (1917) assayed 0.8 percent copper, and $3.72 in gold and $0.70 in silver per ton (price of gold then was $20 per ounce).

A second shaft was sunk in the Ledge in 1925 to a depth of 33 feet, at a locality on the west edge of Sweetwater Canyon. One carload of ore was shipped from this working.

The last mining on this claim was in 1942, when about 35 tons of ore was produced for H. J. Stevenson.

(5) *Last Chance Claim.* The Last Chance claim adjoins the south endline of the Josephine claim, and covers the south part of the north-northwest trending Last Change Ledge, which is exposed along the east side of Mineral Ridge. The principal working on the claim is the Last Chance "Tunnel," a crosscut adit that was driven west-southwestward into the Last Chance Ledge from a point on the west edge of Sweetwater Canyon (fig. 28). The adit was driven in 1943 by the Symons Brothers Development Company, and comprises the most extensive recent work done on the Ord Mountain property. It is 330 feet long, and cuts the Last Chance Ledge at a point 235 feet from the portal. At the point of intersection, the Ledge is about 25 feet wide and shows only sparsely distributed grains of copper minerals, but abundant stains of iron oxide minerals. At a point 200 feet west of the portal of this adit, is an old shaft that was sunk on a fissure vein exposed about 40 feet east of the Last Chance Ledge. The shaft was inclined 70° west on the vein to a depth of 23 feet. At the collar of the shaft the vein is about 9 feet wide.

(6) *Modesto Claim.* The Modesto claim lies to the northeast of, and partly overlaps, the north end line of the Josephine claim. The claim encloses a northeast-trending fissure vein about 600 feet long which is exposed on the north side of Sweetwater Canyon. The vein cuts across the northeast-trending contact between keratophyre and extrusive rocks of the Ord Mountain Group at a very small angle. An 80-foot shaft sunk on this vein is said to have exposed a copper-bearing zone 9 feet wide.

(7) *Rio Vista-Central-England Claims.* The Rio Vista, Central, and England claims are the southernmost claims of the Ord Mountain mine property. The Rio Vista and Central claims are contiguous and lie along the trace of the Coupon Ledge of the Ord Mountain fissure vein system, which strikes northward along the west slope of Ord Mountain (fig. 29). The Central is the more northerly of the two claims and abuts the Coupon claim, which lies to its north. The England claim lies west of the Central claim. The part of the Coupon Ledge explored by workings of these claims dips about 70° east and is quite variable in width. The Ledge comprises a series of closely spaced, nearly parallel, mineralized faults, the principal of which compose a fault zone that separates extrusive metavolcanic rocks of the Ord Mountain Group on the east and hybrid rocks and keratophyre of the Ord Mountain Group on the west. Within this fault zone, in the north part of the Rio Vista claim, have been found the principal ore bodies worked in the Ord Mountain mine (pl. 1) .

The principal workings of these claims are in the S½NE¼ sec. 24, T. 7 N., R. 1 E., S.B.M., and consist of an upper and a lower part, which together comprise four levels (pl. 2). The dimensions of the workings are shown in table 5.

Figure 29. View north-northeastward shows the inactive workings of the Central and England claims (lower left) and the Rio Vista claim, of the Ord Mountain mine, which are on the western slope of Ord Mountain. These workings develop the Coupon Ledge. The dark rocks above the Ledge are chiefly andesite of the Ord Mountain Group of Triassic (?) age, and the rocks below are hybrid rock of Jura-Cretaceous (?) age.

Table 5. A compilation of the dimensions of the workings of the Central-Rio Vista-England claims.

Elevation (in feet)	Level	Total length (in feet)		Stope dimensions (in feet)		
		X-Cuts	Drifts	Back	Length	Width
5260*	I†	60	--------	30-40	60	20
5215*	II†	30	130	30	35	10
5175*	III†	270	180	10-35	80	10-15
5025*	Central Tunnel (IV)	770	550 (?)	?	?	?

* Elevations estimated from Ord Mountains quadrangle.
† These levels are connected by an 85-foot stoped raise.

(a) The upper or Rio Vista workings contain three of the levels—Levels I, II, and III (numbered downward): Levels I and III, which are 85 feet apart vertically, were developed from eastward-driven crosscut adits. Level II was developed as drifts, stopes and raises above Level III. Of the three main ore bodies that have been worked in the Rio Vista workings, the principal body extends from the surface of the mountain to Level III, between the foot and hanging walls of the Coupon Ledge, and is point-wedge shaped downward. It dips about 65° east and has the following dimensions: plunge length, 125 feet; width, less than one foot on Level III, increasing to about 20 feet on Level I; and strike length, less than one foot on Level III, gradually increasing to about 60 feet on Level I. The body is composed chiefly of quartz, hydrous iron oxide minerals, chalcopyrite, and chrysocolla. In regard to its grade, Place (1917) stated: "If properly grouped the assays give an average width of vein of six feet and an average assay in copper of 4% and $6.25 in gold and silver."

The second ore body that has been mined in these workings was intersected at the north end of Level II (pl. 2); and as the body has been worked only on this level, and to a point 30 feet above, its shape has not been fully determined. On Level II the body ranges in width from 7 to 9 feet, and has been mined along its strike for a distance of about 60 feet. Its footwall dips about 55° east and its hanging wall about 65° east. The deposit consists chiefly of finely disseminated chalcopyrite in quartz, with crusts and stains of chrysocolla, and very subordinate proportions of azurite and malachite. The grade of the ore mined was perhaps 3 to 4 percent copper.

The third body has been mined most recently, in 1942, by H. J. Stevenson, of Los Angeles. This body was discovered at the south end of Level III by drifting, and has been worked only from this level. The body strikes about N. 16° W. and dips about 65° east. On the level its width ranges from less than 5 feet to about 20 feet, and its strike length is about 50 feet. A chalcopyrite-rich pillar of ore that remains in the stope shows that on the level parts of the body contained as much as perhaps 5 or 10 percent copper. Ore shipped by the company averaged 0.2 ounces of gold, 0.12 ounces of silver per ton, and 2.1 percent copper.

(b) The lower part of the principal workings of the Rio Vista-Central-England claims consist of the Central Tunnel, a crosscut adit (Level IV), which was driven eastward toward the Coupon Ledge in 1925 from a point on the England claim, about 400 feet west-northwest of, and 150 feet lower than, the portal of Level III of the Rio Vista workings (fig. 29). The adit is 770 feet long, with appended drifts that extend north and south on the Coupon Ledge, from a point 700 feet east of the portal of the adit, in ground covered by the Central claim. In 1953, the adit was caved beyond a point about 575 feet from the portal. J. L. Carder stated (personal communication, 1955) that the drifts "cut vein 30 feet wide, 15 feet of sulfide ore, with values of copper to 9 percent." Specimens of the vein rock found on the dump by the writer were composed chiefly of quartz and bornite, with subordinate proportions of chalcopyrite and chalcocite.

The principal working developed from the surface of the Central claim is a 64-foot winze which was sunk from a short, east-driven crosscut adit whose portal is about 450 feet north-northeast of the portal of Level III of the Rio Vista workings (pl. 1). These workings intersected two veins which are 5 and 14 feet wide. A composite sample of the veins taken by Place (1917) showed 3.7 percent copper and $3.18 in gold and silver (gold valued at $20 per ounce).

Economic Considerations. A definite zone in which ore bodies have been mined, and additional ones may be discovered, lies between the surface of the Rio Vista workings and the Central Tunnel in the Coupon Ledge. The plunge length of this zone is about 300 feet, and the strike length is at least the strike length of the part of the Ledge developed by the Rio Vista workings, which is about 250 feet. Undiscovered bodies of ore minerals in this zone probably could be discovered by a proper diamond drilling program.

PAINSVILLE MINE

The Painsville gold-copper mine is covered by the Painsville claim which was patented about 1890. This claim adjoins the south endline of the Rio Vista claim of the Ord Mountain mine. The principal workings are near the center of the E½ sec. 24, T. 7 N., R. 1 E., S.B.M. The mine is owned by Mrs. I. D. Garringer of Los Angeles (1956).

Ownership of the Painsville claim was separated from the ownership of the Ord Mountain property at an undetermined date before 1890 and since that time the claim has been largely inactive. Development consists principally of a 30-foot shaft on the Coupon Ledge which at this locality is 15 to 20 feet wide and dips 60° east (fig. 11).

RED HILL PROSPECTS

The Red Hill prospects are in the S½SE¼ sec. 31, T. 7 N., R. 2 E., S.B.M., on a low, north-trending ridge at the southeast edge of Ord Mountain. A dirt road leads to the area from Tyler Valley. The area probably was first prospected for copper and gold during World War I and perhaps even before that time. In 1962, Leonard Shouse, 2831 Shakespeare, San Marino held four unpatented claims on the deposit and had done a small amount of exploratory and development work. Included in this work was the core-drilling of a 490-foot hole.

The prospects explore several narrow, north-northeast-trending, steeply-dipping quartz veins and hydrothermally mineralized rhyolite dikes in metavolcanic rocks of the Ord Mountain Group. The longest vein is exposed for about 1,000 feet. The deposits contain a small proportion of copper minerals, including chrysocolla, chalcopyrite, and chalcocite. Molybdenite, with its alteration product powellite, is abundant at several localities in quartz veins and mineralized rhyolite dikes.

CONTACT METASOMATIC DEPOSITS

Two mineral deposits in the Ord Mountain district are herein classified as "contact metasomatic" *: a tungsten (scheelite-bearing) deposit known as the White Dollar mine, and the Ord Mountain iron (magnetite) deposit. Both are in the northeast part of the district, and are about 4,000 feet apart (pl. 1).

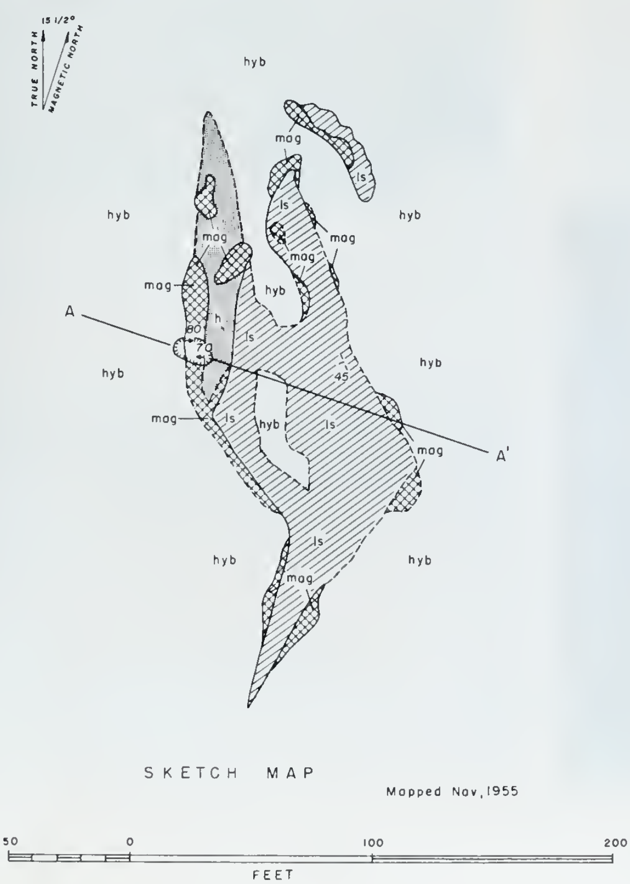
Ord Mountain Iron Deposit

The Ord Mountain iron deposit is at the center of the boundary between the SW¼ sec. 5 and the SE¼ sec. 6, T. 7 N., R. 2 E., S.B.M., along the east side of the crest of a low, north-trending ridge. The property can be reached easily by a faint trail from the county road which skirts the northeast edge of the district. The owner of the property is undetermined. The deposit is developed only by a shallow trench, which is about 15 feet long.

The deposit consists of thirteen rather small bodies of magnetite which crop out along the edge of a lenticular inclusion of crystalline limestone in hybrid rock (fig. 30). The largest of the bodies is about 100 feet long and 10 feet in maximum width. Lying between the limestone and the hybrid rock is a dense, dark greenish-gray hornfels which may be a metamorphosed volcanic rock. The hornfels is highly epidotized near contacts with bodies

* Contact metasomatic deposits have been defined by Bateman (1950, p. 82) as those deposits which are formed as a result of high temperature gaseous emanations escaping into the wall-rock from an intrusive magma during or slightly after its consolidation.

Figure 30. Geologic sketch map of and cross section through the Ord Mountain iron deposit.



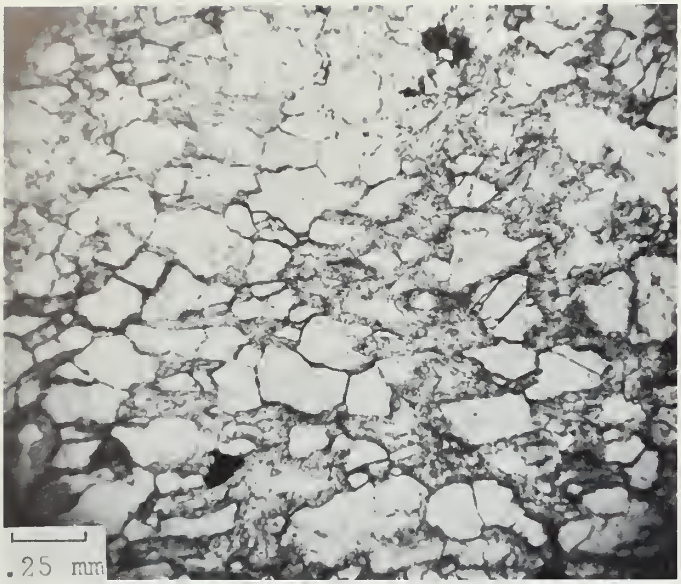


Figure 31A. Photomicrograph of thin section in ordinary light showing barren limestone. Section contains only a few grains of magnetite (opaque) with the intergranular calcite (light-colored), siderite (?) and antigorite (darker mineral). Ord Mountain iron deposit.

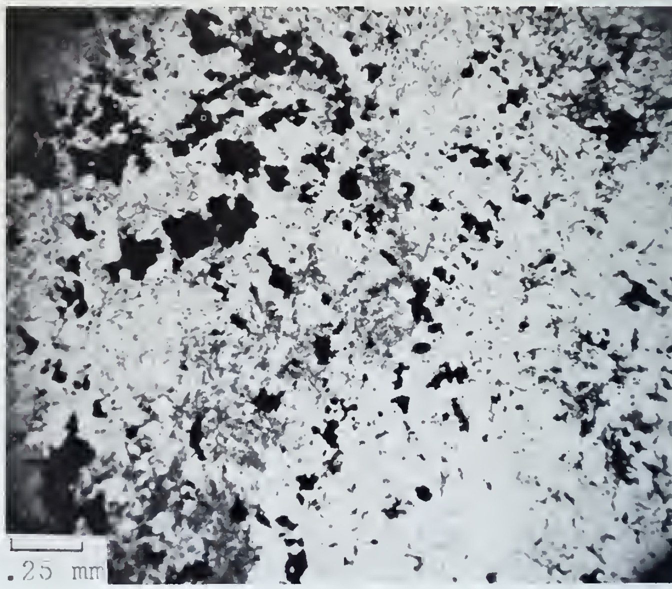


Figure 31B. Photomicrograph of thin section showing more advanced stage of replacement than is shown in figure 31a. Secondary minerals in addition to magnetite and siderite (?) are scapolite and diopside (darker minerals). Ord Mountain iron deposit.

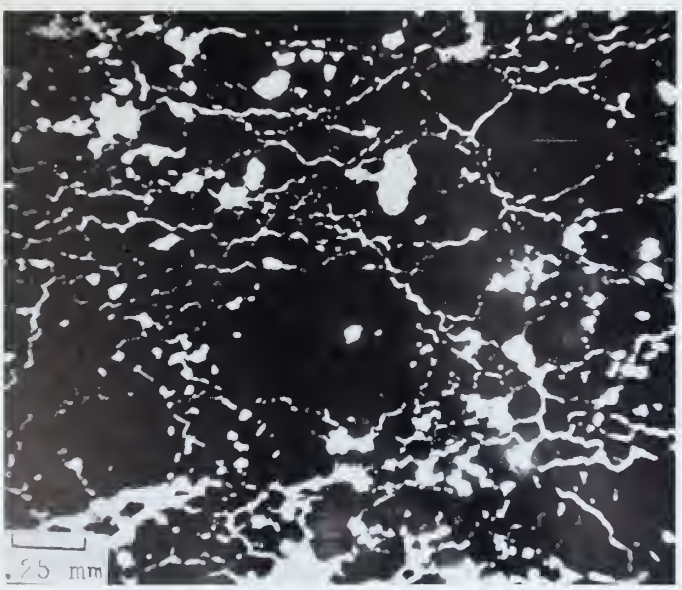


Figure 31C. Photomicrograph of thin section in ordinary light showing nearly pure magnetite. Section contains only a few residual remnants of calcite and secondary siderite (?).

Figure 32. Part of Ord Mountain iron deposit. View northeast shows crystalline limestone at lower right, hornfels from lower left corner to middle right edge, and magnetite from center of left edge to middle of view, beneath claim marker (4 in. x 4 in. in cross section). Hybrid rock is shown beneath skyline on left edge.

of magnetite, and it is chloritized near a contact with hybrid rock.

Progressive transition by replacement from nearly barren crystalline limestone to nearly pure magnetite, is shown in figures 31a to 31c. The transition is not a visible gradational relationship between the bodies of magnetite and the limestone, however, as these contacts generally are very sharp (fig. 32). Instead, the figures illustrate the way that magnetite has replaced limestone by metasomatism. Where no bodies of magnetite are present along the contact between limestone and hybrid rock, masses of magnesite as much as one foot thick have developed.

One thin section of the hybrid country rock from the locality was examined. In it the rock has an equigranular texture and is silicic in composition. The primary minerals are albite-orthoclase (45 percent), quartz (35 percent), and very small proportions of magnetite-ilmenite and sphene. Secondary minerals are thread-like aggregates of hornblende (5 percent) in veinlets with quartz and albite (10 percent).

White Dollar (May Day) Mine

The White Dollar tungsten mine is in the E½SE¼ sec. 7, T. 7 N., R. 2 E., S.B.M., in a canyon on the long interfluve that juts out to the east from the northeast end of Ord Mountain. A road leads southward to the deposit from the county road which skirts the northeast part of the district. In 1953 the mine property consisted of three unpatented claims held by the estate of the late J. Ralph McInerny, who lived in San Bernardino, California. The name of the administrator of the estate was not determined during this study.

The deposit was opened early in World War II, and was operated most recently during 1951, and from February to June 1952, by the Parker Mining and Milling Company. It has yielded only a small tonnage of ore. The ore mined in 1951 averaged 0.3 percent tungsten trioxide. However, the ore mined during the latter period of the operation is said to have assayed as high as 1.4 percent tungsten trioxide (WO_3).

Scheelite occurs in two north-northwest trending metasomatized shear zones in metamorphic extrusive rhyolite and andesite of the Ord Mountain Group. The zones are within several hundred feet of each other and the more easterly zone is within a few hundred feet of the contact between the metavolcanic rocks and a body of fine-grained granite. The more easterly zone has been the principal source of ore and is shown on plate 1. This zone strikes N. 15°-25° W., dips about 65° west (parallel to the metavolcanic rocks), and is at least 1,700 feet long. Its width appears to be variable, as the intensity of metasomatic alteration decreases irregularly outward from the heart of the shear zone for about 150 feet, where the contact metasomatic alteration cannot be distinguished from the regional alteration of the metavolcanic rocks.

The groundmass of the metavolcanic rocks, where moderately altered, is an aggregate of fine-grained diopside (which is transected by veinlets of an aggregate of quartz and albite), quartz, and a carbonate mineral. Phenocrysts of feldspar have been albitized. Intense alteration in the heart of the shear zone has obliterated nearly all remnants of the original texture of the metavolcanic rocks; and the resultant rock is a hornfels composed of quartz, grossularite, epidote, and magnetite-ilmenite, with subordinate proportions of chlorite, scheelite, a carbonate mineral, and pyrite. This rock is very fine- to medium-grained and has a xenoblastic texture. Near the heart of the shear zone silicification is intense but outward is less pronounced, and outward albitization becomes more intense. Movement along the shear zone since the period of metasomatism has brecciated the hornfels which subsequently has been recemented with chalcedony. Even more recent movement has formed a banded, chloritic, clay-like gouge and breccia zone a few feet thick.

A sample of scheelite-rich hornfels from the workings of the mine was studied in thin section (fig. 33). The thin section consists of about 90 percent quartz, with subordinate proportions of epidote, grossularite, magnetite-ilmenite (partly altered to leucoxene and hydrous iron oxide minerals), scheelite, and fluorite.

Figure 33. Photomicrograph of thin section in ordinary light showing scheelite (sc) adjacent to a veinlet composed of layers of quartz (q), fluorite (fl) and epidote (ep).

The more easterly zone of mineralization has been developed along its strike for about 1,000 feet. The principal working in this zone is a 30-foot inclined shaft, from the bottom of which is a drift that was driven about 75 feet northward into the zone. From a point 40 feet northwest of the collar of the shaft, and several feet higher, a drift adit extends about 50 feet eastward into the zone. Several hundred feet directly west of the portal of this drift adit, in the subordinate zone of mineralization mentioned above, a 30-foot shaft was sunk.

UNNAMED MANGANESE-TRAVERTINE DEPOSIT

A deposit that consists of cream-colored travertine in layers totalling several feet in thickness, with small proportions of a manganese oxide mineral, occur in the northwest corner of the area mapped (SE¼ sec. 3, T. 7 N., R. 1 E., S.B.M.). The deposits strike northwest for several hundred feet, adjacent to the Tyler Valley fault, and dip about 60° northeast. The manganese probably is too low in grade for the deposit ever to be considered as a possible ore deposit.

SILICA

The prominent bull quartz vein in the northwest system of veins, and the more westerly part of the longest vein in the northeast-central area of veins, might be considered as possible commercial sources of quartz.

McKNIGHT "CORNISH STONE" DEPOSIT

A deposit of cornish stone in the district was reported by Tucker and Sampson (1930, p. 305) to be claimed by H. E. McKnight, of Los Angeles. The deposit was said to be in sec. 16, T. 7 N., R. 2 E., S.B.M., just south of Willis Well. This locality, as reported, would place the McKnight deposit in feldspathic quartzite, which may have been mistaken for true cornish stone * (see description of feldspathic quartzite in section on "Geologic features").

This deposit was under consideration in 1961 by a southern California minerals company as a possible source of material for use in ceramics.

PLACER GOLD DEPOSITS

Placer deposits in the northwest part of the district, near the center of the W½W½ sec. 11, T. 7 N., R. 1 E., S.B.M., presumably have been worked for gold. The deposits comprise a thin veneer of older alluvium which rests on fine-grained granite and hybrid rock. The deposits have been prospected during an undetermined period or periods and are developed by shallow pits.

* Cornish stone is a silica-rich, kaolin-like rock.

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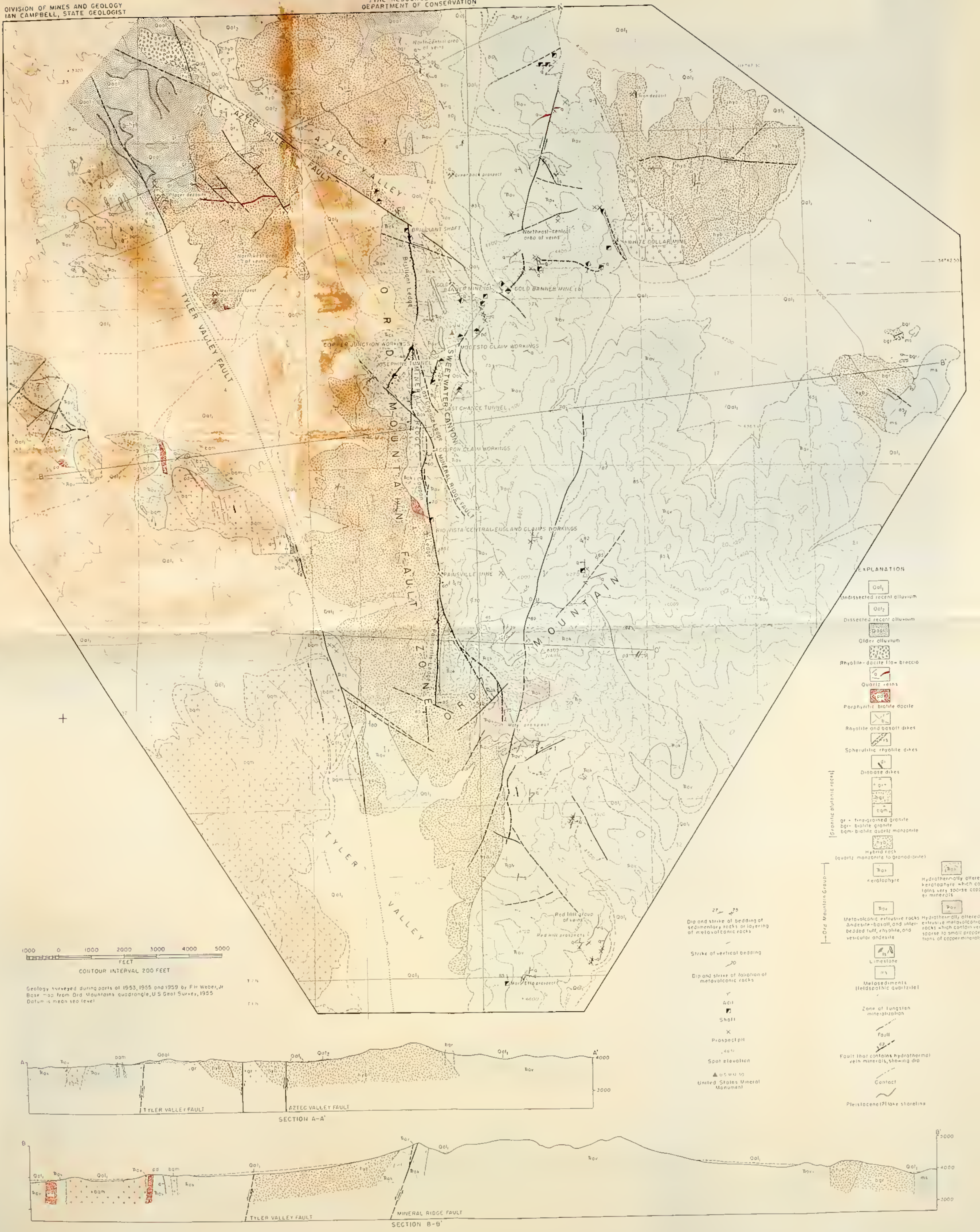
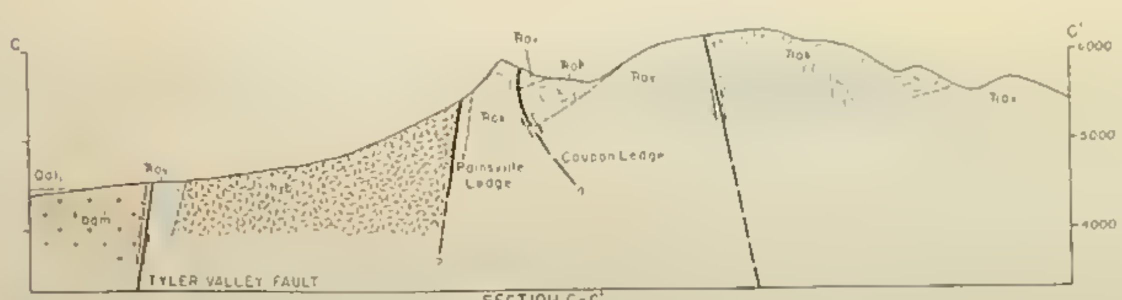
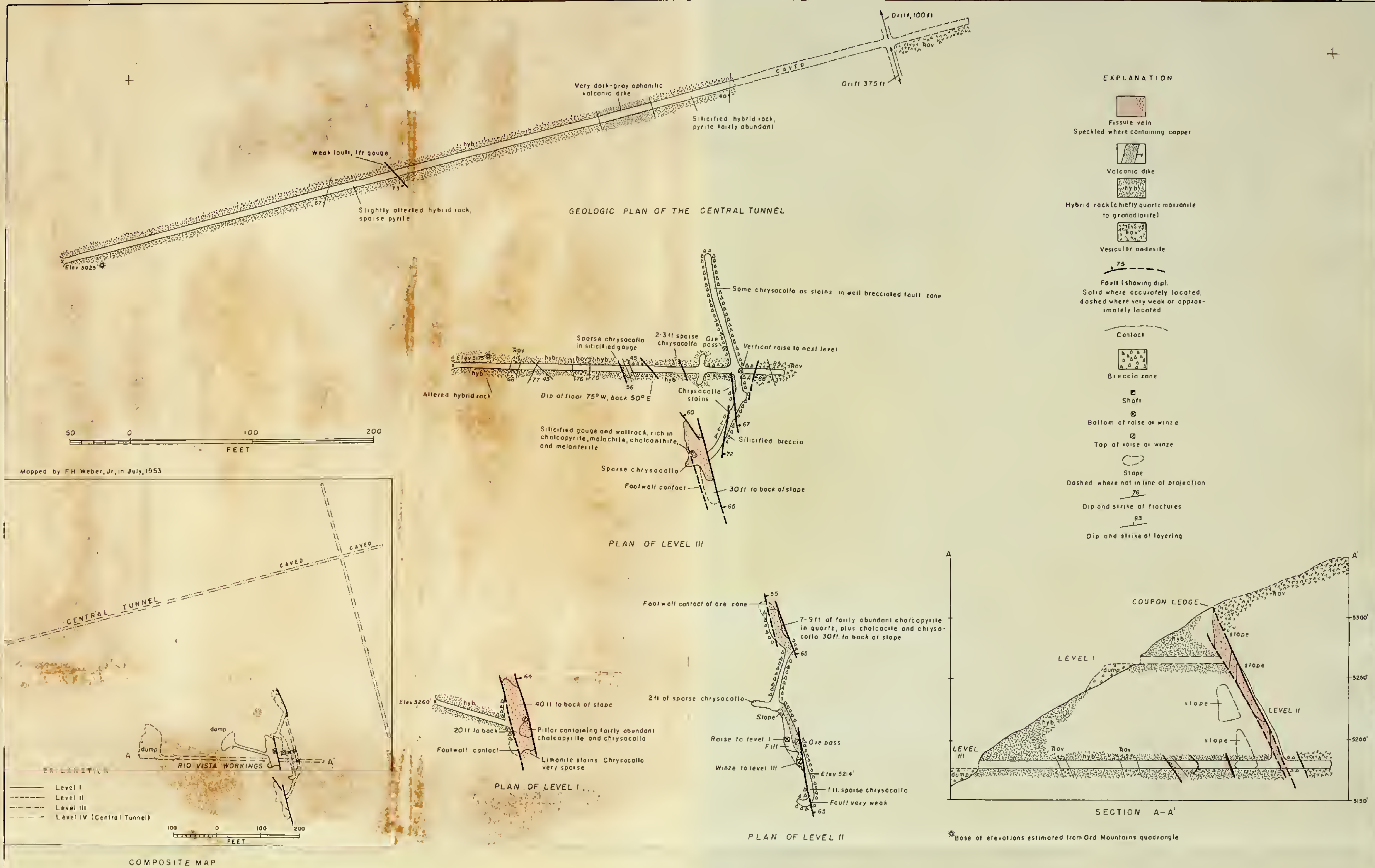




GEOLOGIC MAP AND SECTIONS OF THE ORD MOUNTAIN DISTRICT SHOWING MINES AND PROSPECTS SAN BERNARDINO COUNTY, CALIFORNIA



GEOLOGIC PLANS, COMPOSITE MAP, AND LONGITUDINAL PROJECTION THROUGH WORKINGS OF THE RIO VISTA-CENTRAL-ENGLAND CLAIMS, ORD MOUNTAIN MINE, SAN BERNARDINO COUNTY, CALIFORNIA